Energy 101—The Big Picture

Energy Trends,
Electric Utility Industry Restructuring,
and the Future

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Disclaimer:

The views in this presentation are
not represented to be official positions
of the U.S. Department of Energy
or
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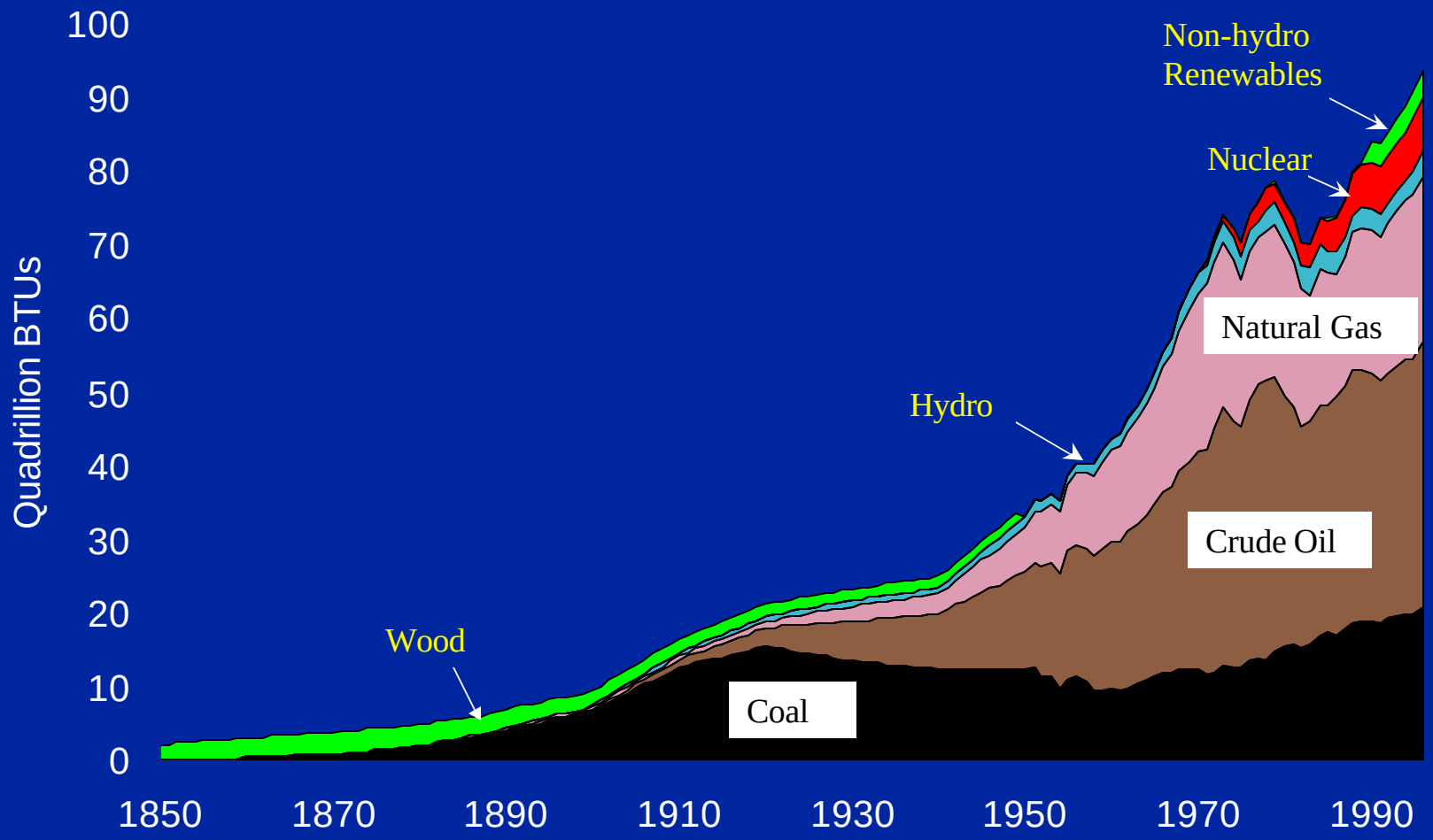
Presentation Outline

- Historic Energy Picture
- Electric Power issues
- Natural Gas issues
- Energy options:
  - Oil
  - Coal
  - Nuclear
  - Renewables
- Electric Restructuring
- Long-term options
- 10 minutes for Q&A

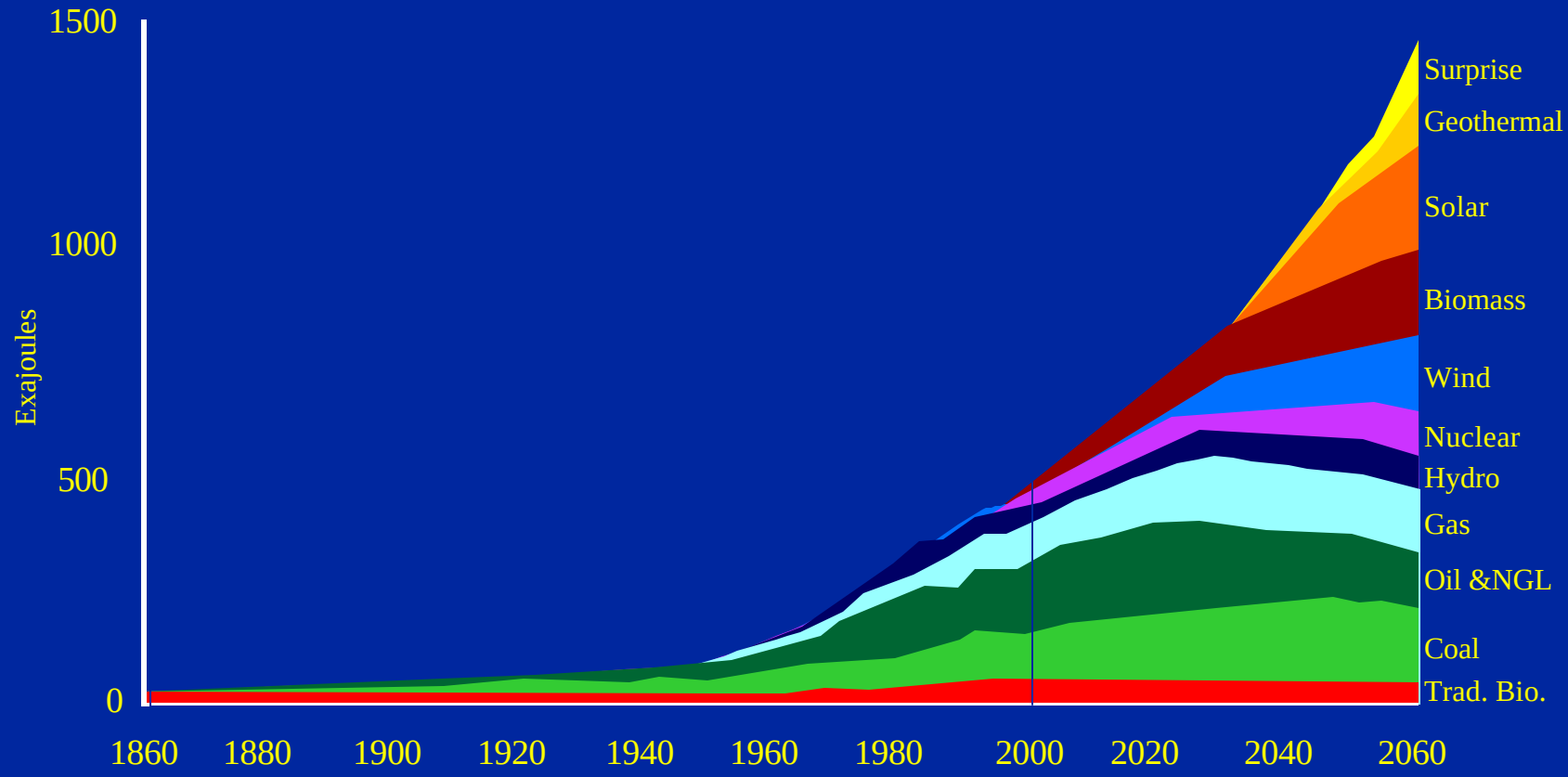
U.S. Energy Consumption by Source

1850-1996



Source: 1850-1949, Energy Perspectives: A Presentation of Major Energy and Energy-Related Data, U.S. Department of the Interior, 1975; 1950-1996, Annual Energy Review 1996, Table 1.3. Note: Between 1950 and 1990, there was no reporting of non-utility use of renewables.

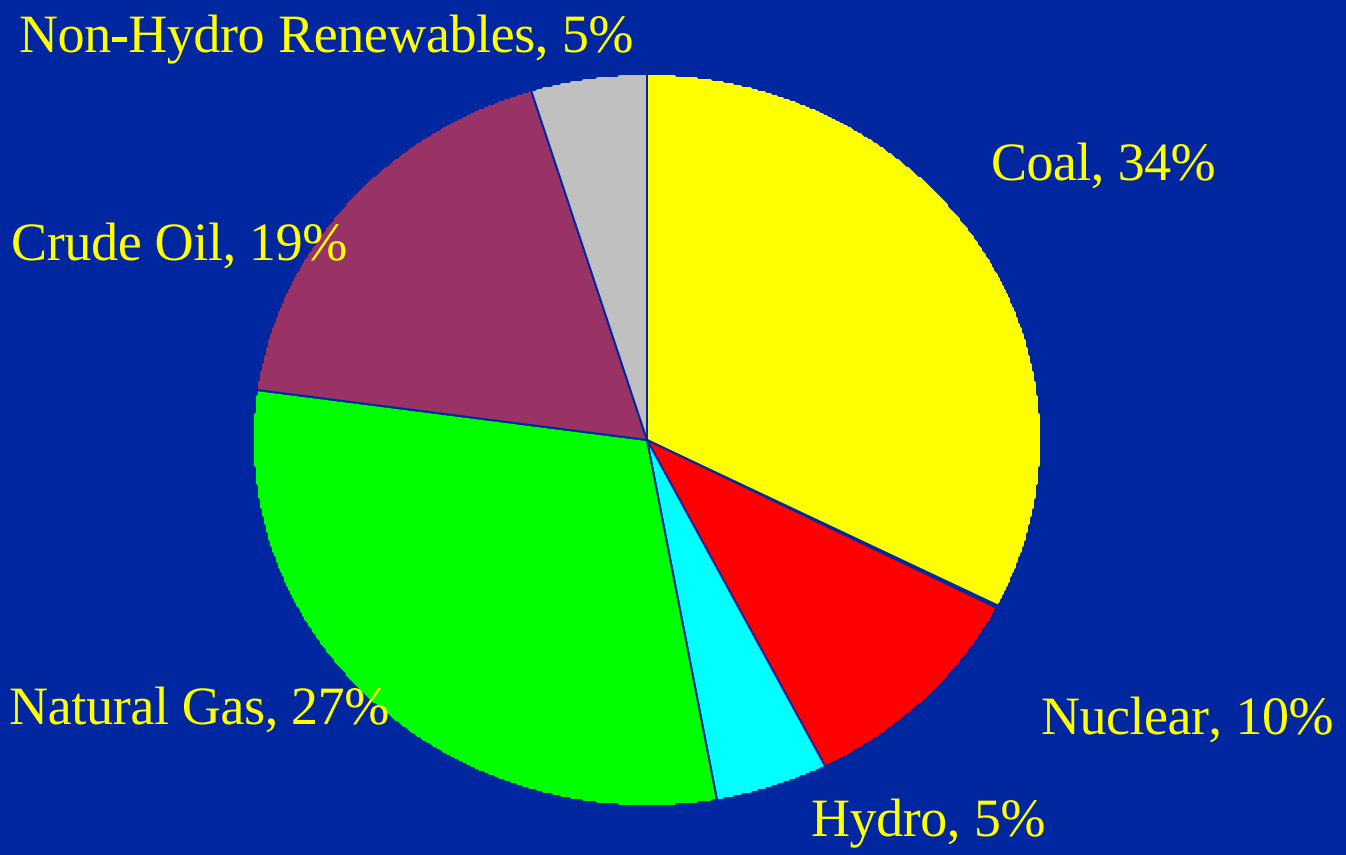
Future Scenario



Source: *Shell, The Evolution of the World's Energy Systems*, 1995

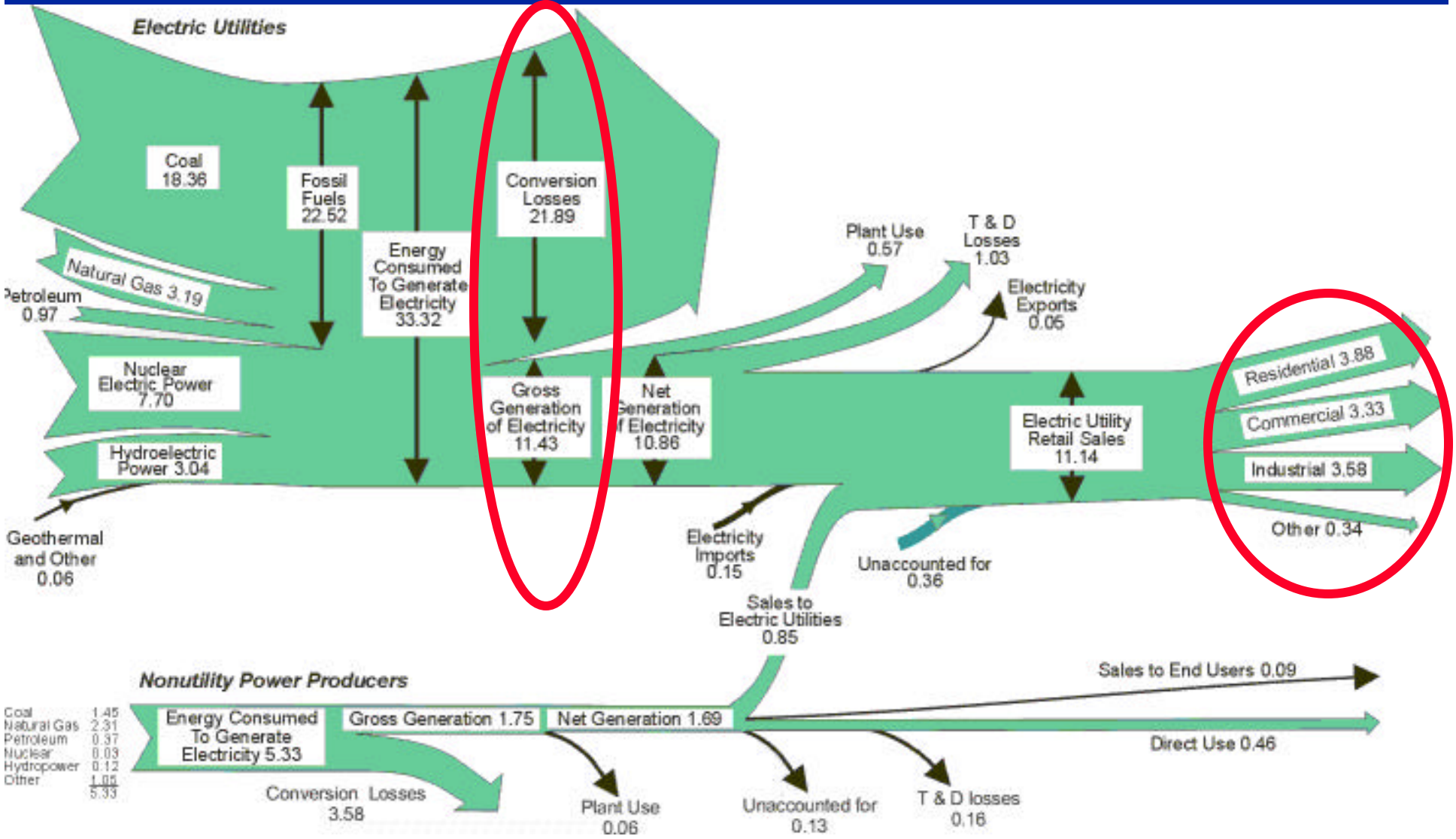
U.S. Energy Production by Source

1998



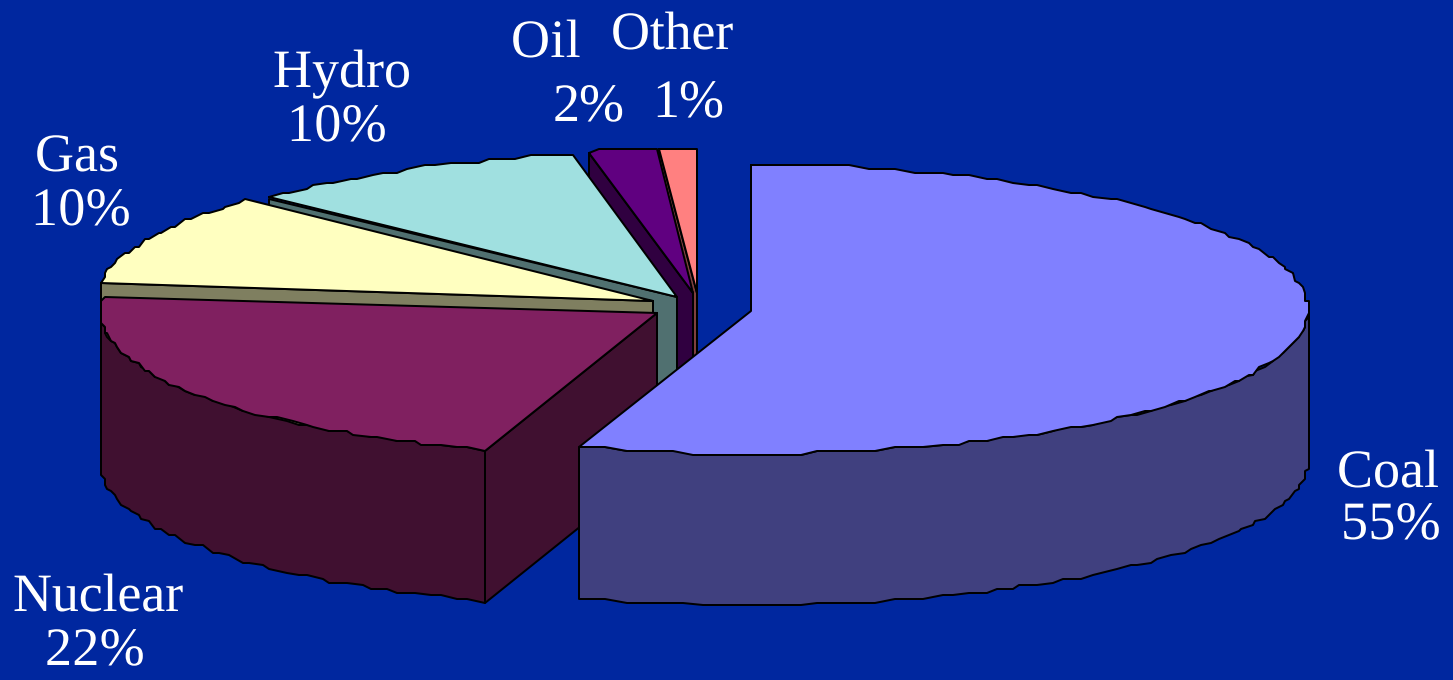
Source: *Annual Energy Review 1998*, Table 1.2

Electric Power

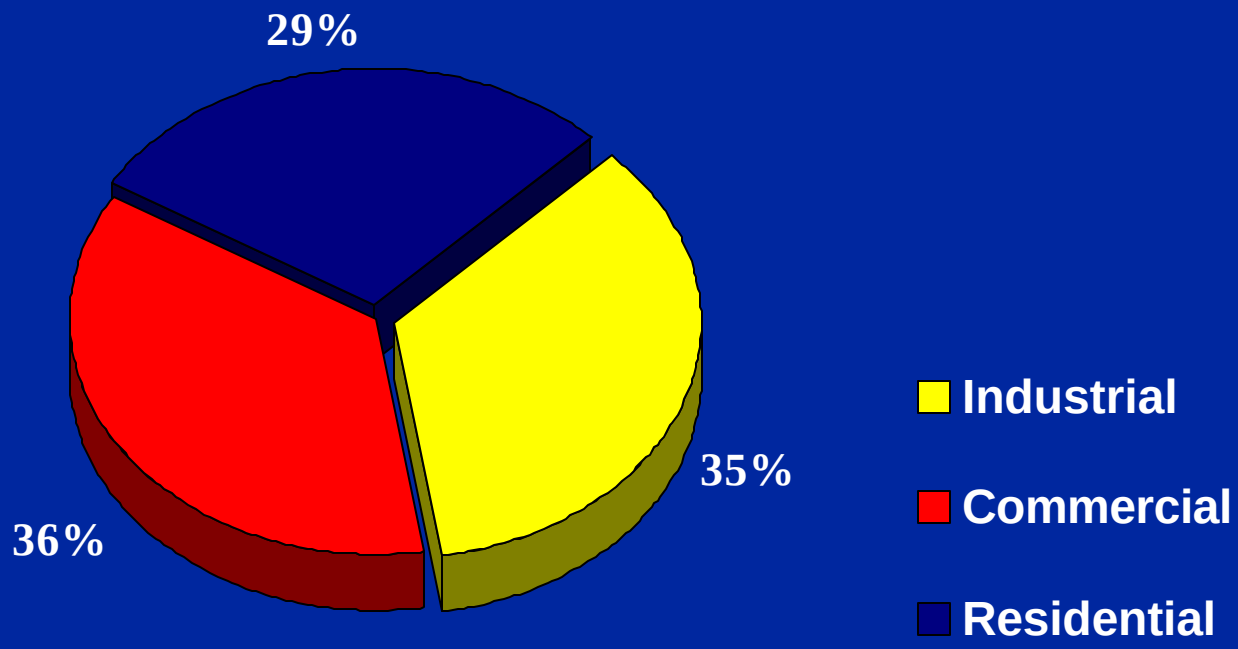

Electric Utilities
Coal 18.36
Natural Gas 3.19
Petroleum 0.97
Nuclear Electric Power 7.70
Hydroelectric Power 3.04
Geothermal and Other 0.06
Fossil Fuels 22.52
Energy Consumed To Generate Electricity 33.32
Conversion Losses 21.89
Gross Generation of Electricity 11.43
Net Generation of Electricity 10.86
Plant Use 0.57
T & D Losses 1.03
Electricity Exports 0.05
Electricity Imports 0.15
Unaccounted for 0.36
Sales to Electric Utilities 0.85
Electric Utility Retail Sales 11.14
Residential 3.88
Commercial 3.33
Industrial 3.58
Other 0.34
Nonutility Power Producers
Coal 1.45
Natural Gas 2.31
Petroleum 0.37
Nuclear 0.03
Hydropower 0.12
Other 1.05
5.33
Energy Consumed To Generate Electricity 5.33
Gross Generation 1.75
Net Generation 1.69
Conversion Losses 3.58
Plant Use 0.06
Unaccounted for 0.13
T & D losses 0.16
Sales to End Users 0.09
Direct Use 0.46

U. S. Utility Net Generation

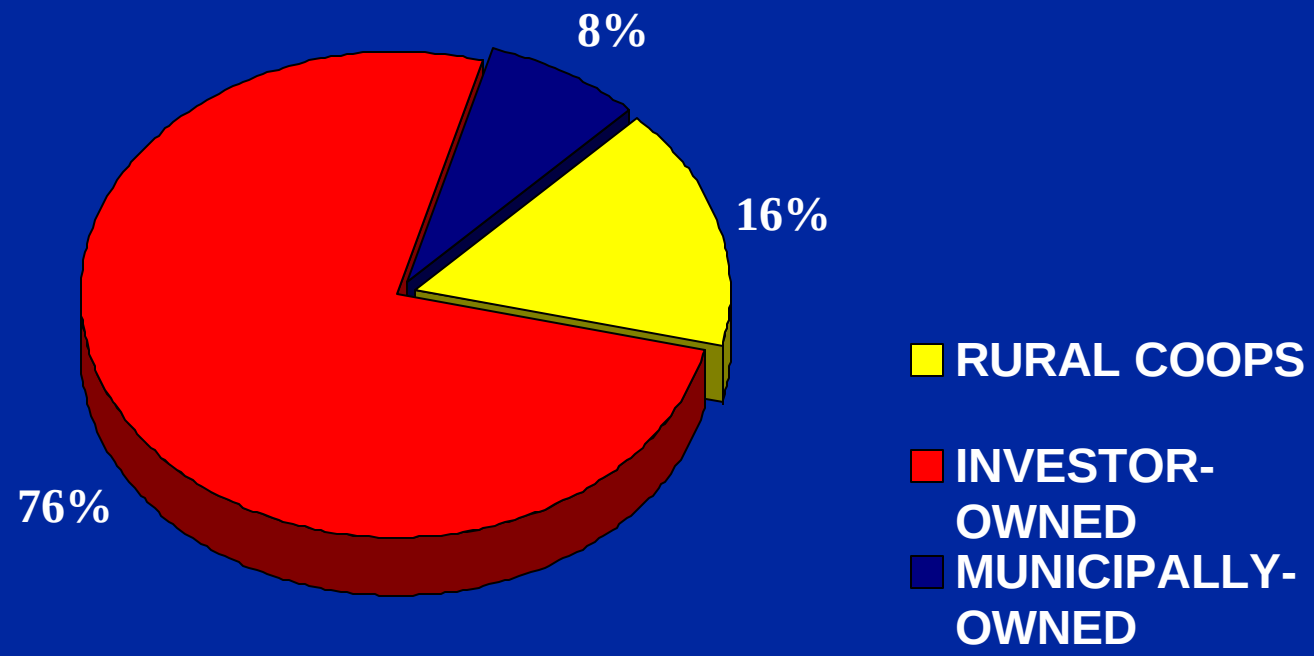
2.99 trillion kilowatt-hours



U.S. Electric Company Sales to Customers

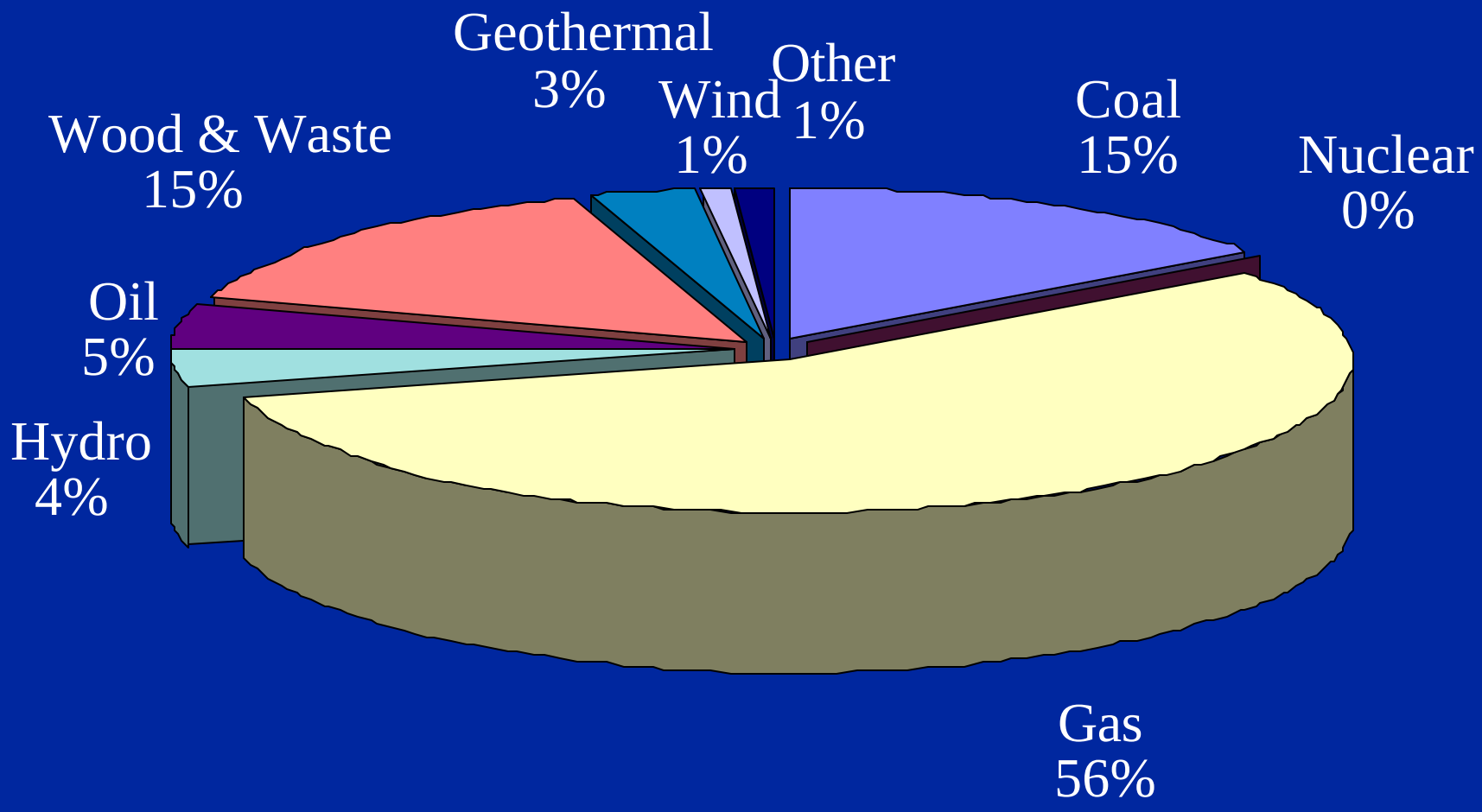


United States Percent of Customers Served By Type of Utility



Non-utility Net Generation

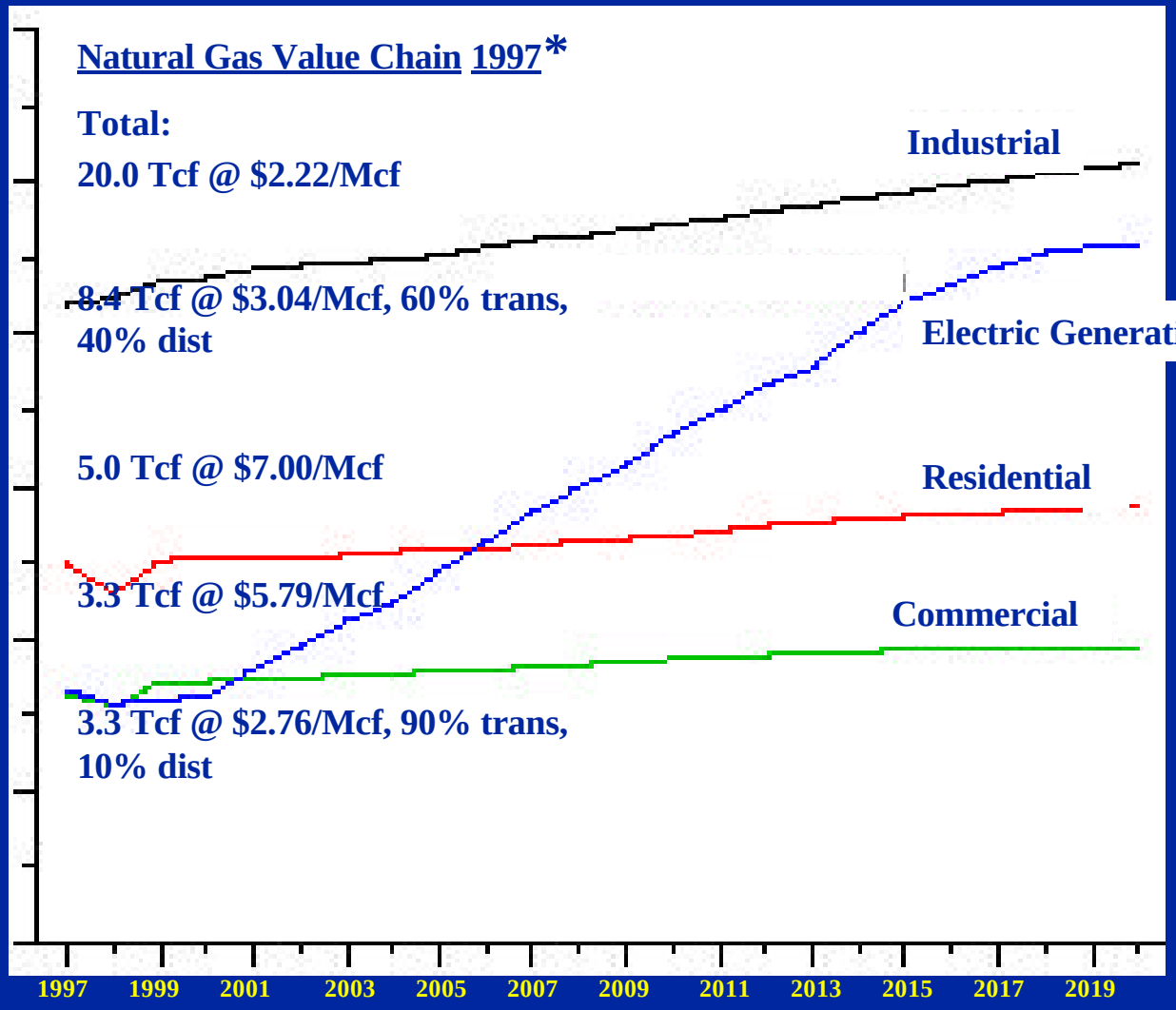
362 billion kilowatt-hours



Regulatory Oversight

ELECTRIC PROVIDERS	JURISDICTION
Investor-Owned Utilities	PUCs and Federal Government
Rural Electric Cooperatives	Members & US Dept of Agriculture
Municipal Utilities	City Councils
Non-utility generators	Federal Government and PUCs
Federal Power Marketing Authorities	Federal Government
Self-Generation	None

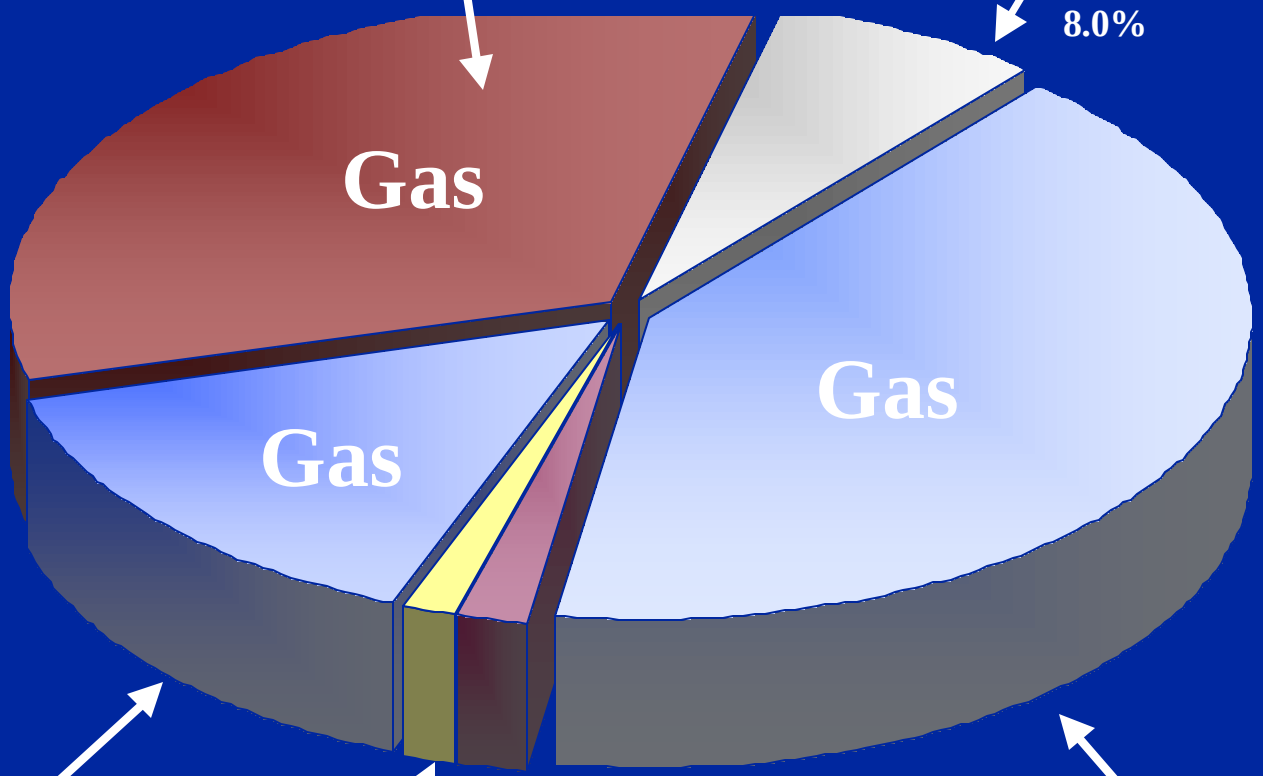
Major Increase in Demand for Natural Gas-fired Generation



**Value Chain Source: Linden, H. R., "Fuel for Thought: Some Questions on the Future of Gas-Fired Generation", Public Utilities Fortnightly, 12/99*

1998 - 2007 Generation Additions

WSCC



COMBUSTION TURBINE
3465 MW
37.2%

HYDRO
742 MW
8.0%

NUCLEAR
0 MW 0.0%

STEAM-COAL
-601 MW -6.4%

STEAM-GAS
-539 MW -5.8%

STEAM OIL
0 MW 0.0%

INTERNAL COMBUSTION
-23 MW -0.2%

HYDRO-PUMPED STORAGE
0 MW 0.0%

COGENERATION
1580 MW
16.9%

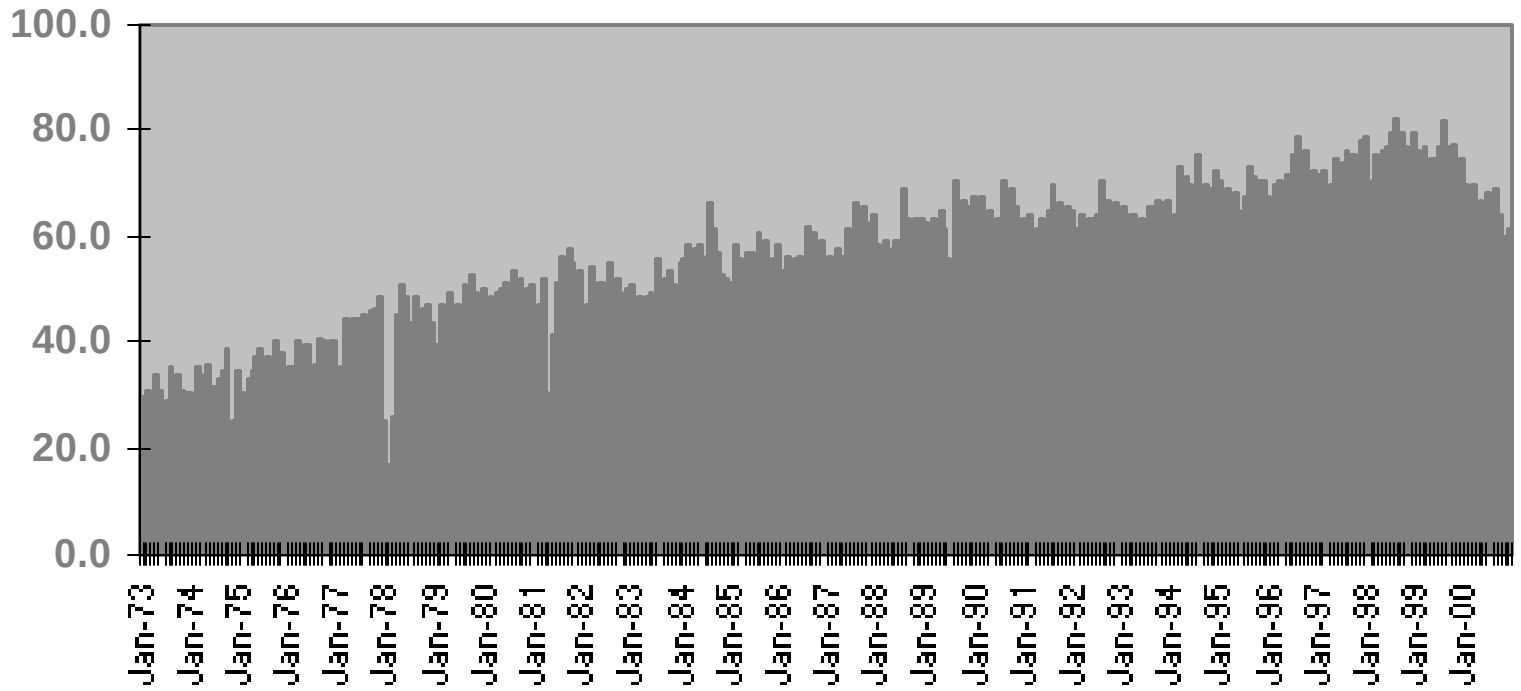
OTHER
154 MW
1.7%

GEOTHERMAL
188 MW
2.0%

COMBINED CYCLE
4359 MW
46.6%

SOURCE: Western Systems Coordinating Council

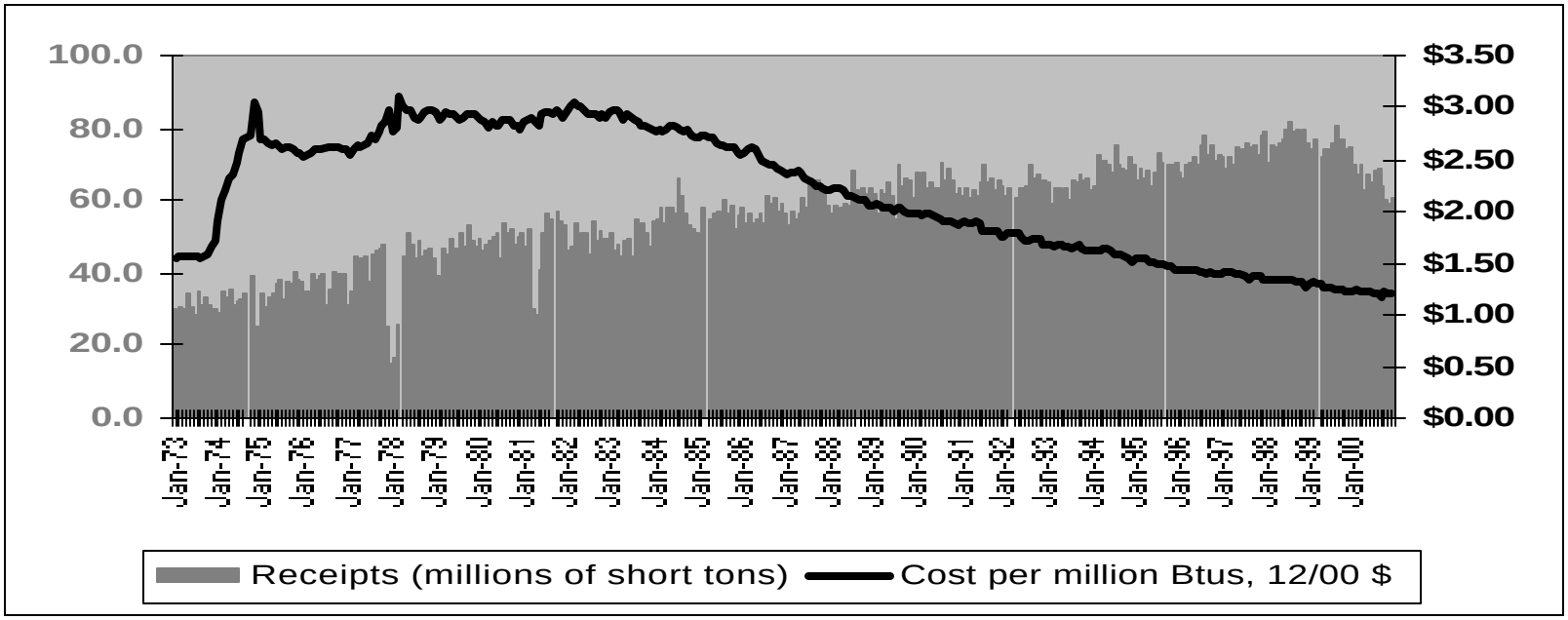
Use of Coal at Power Plants 1973-2000



Source: EIA

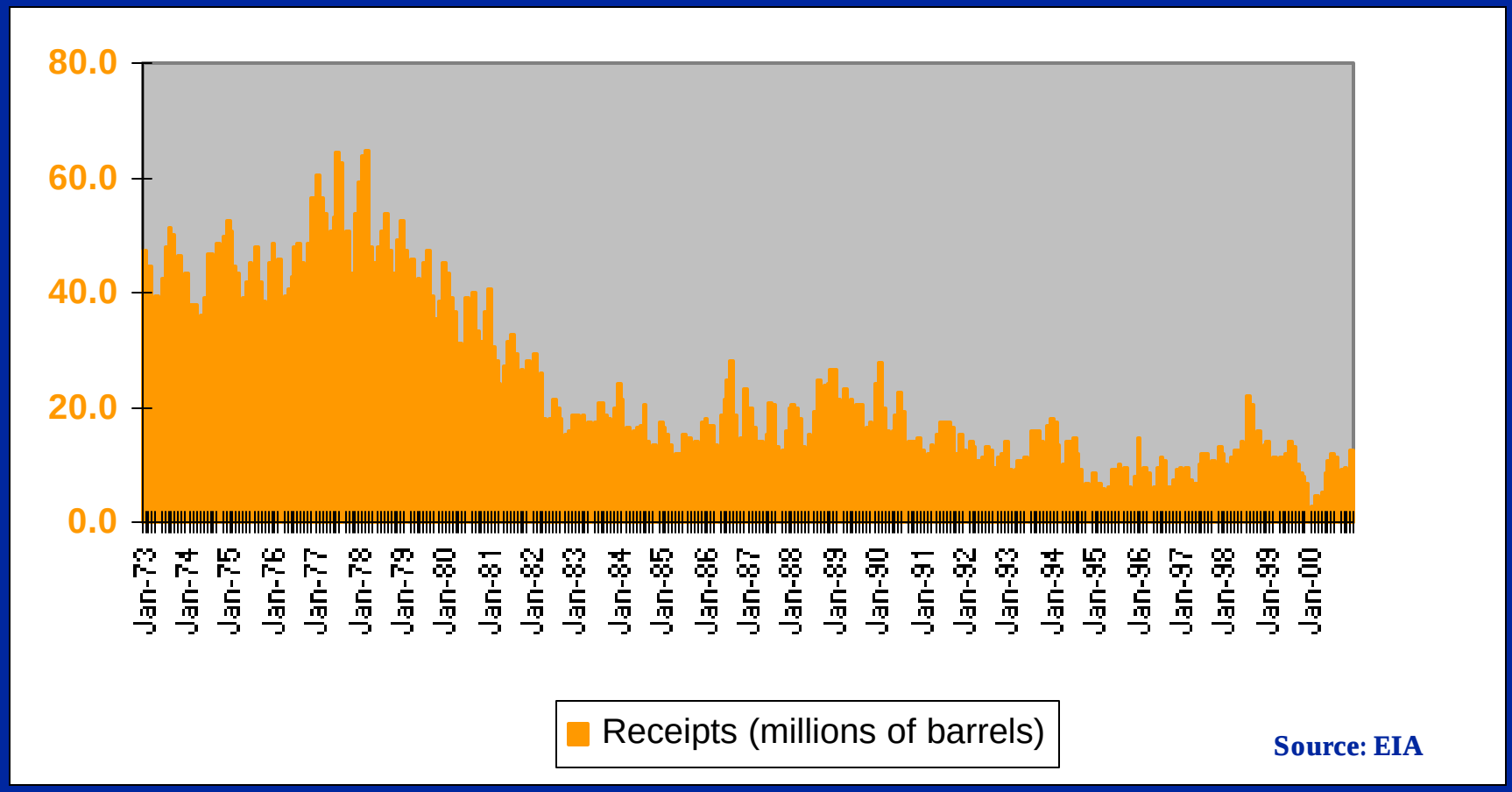
Cost of Coal Used at Power Plants

Coal



Source: EIA

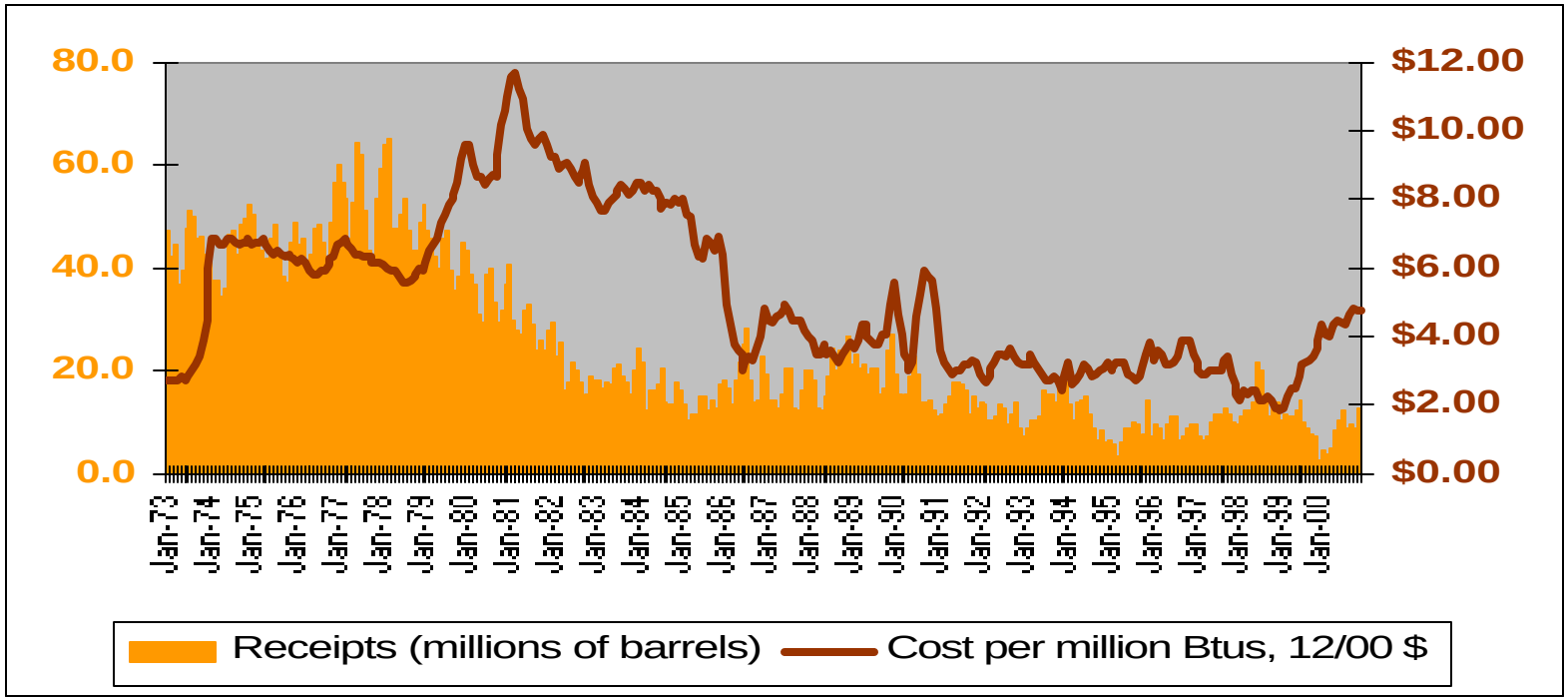
Use of Petroleum at Power Plants



Source: EIA

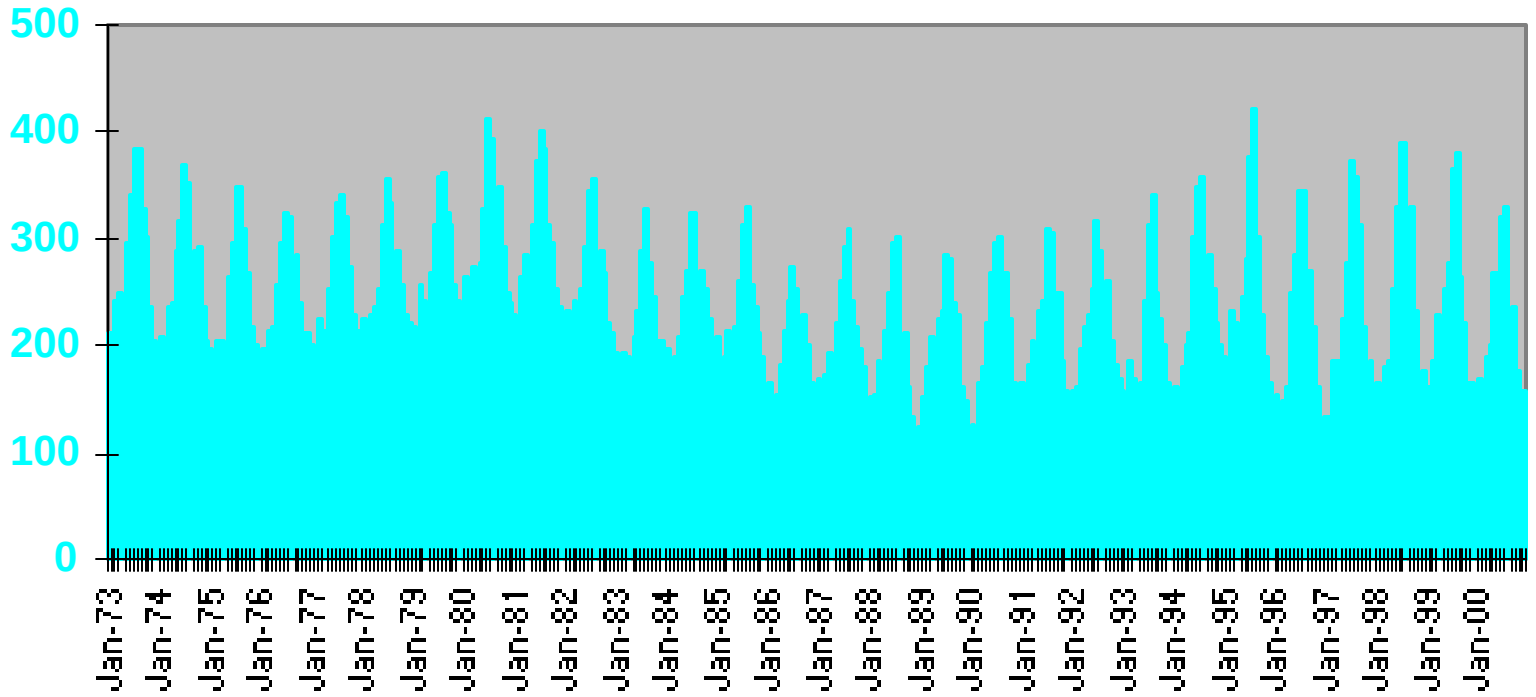
Cost of Petroleum Use at Plants

Petroleum



Source: EIA

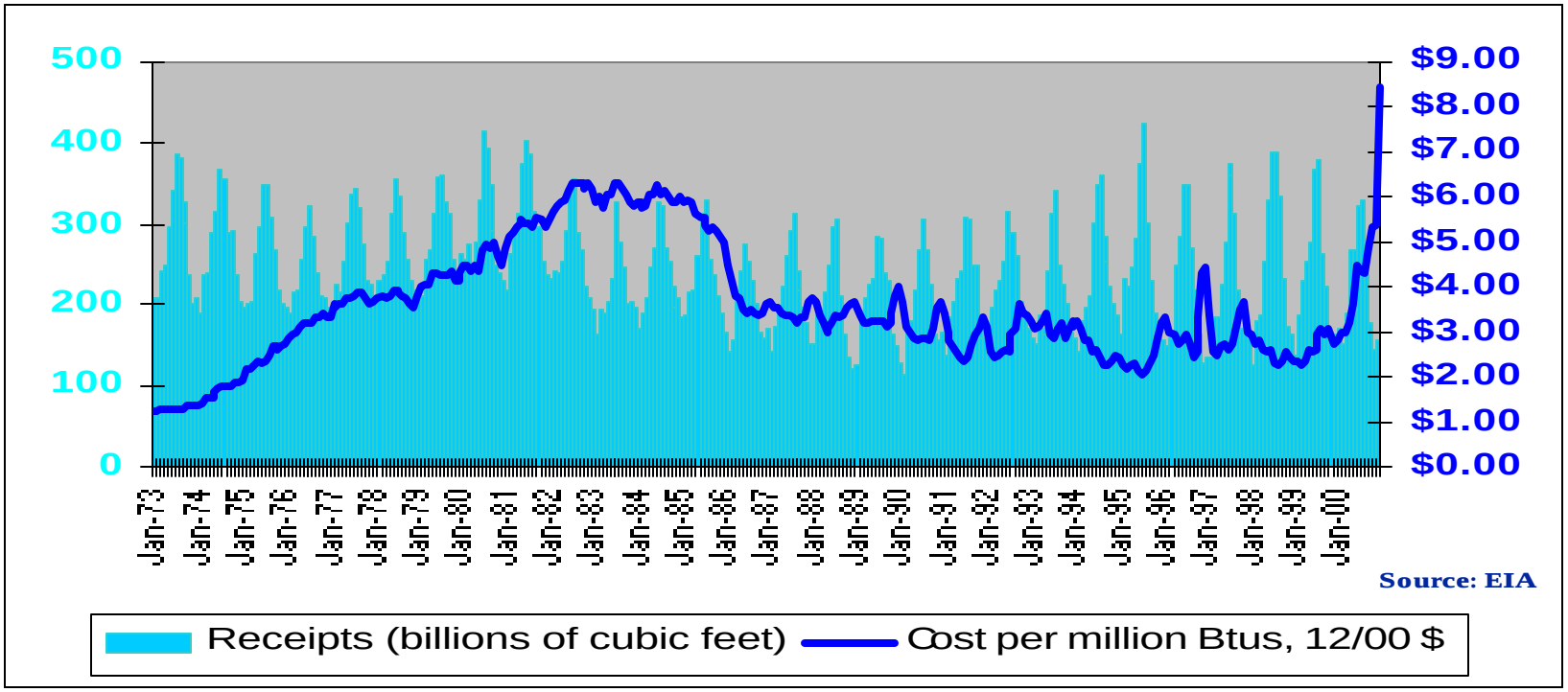
Use of Natural Gas at Power Plants



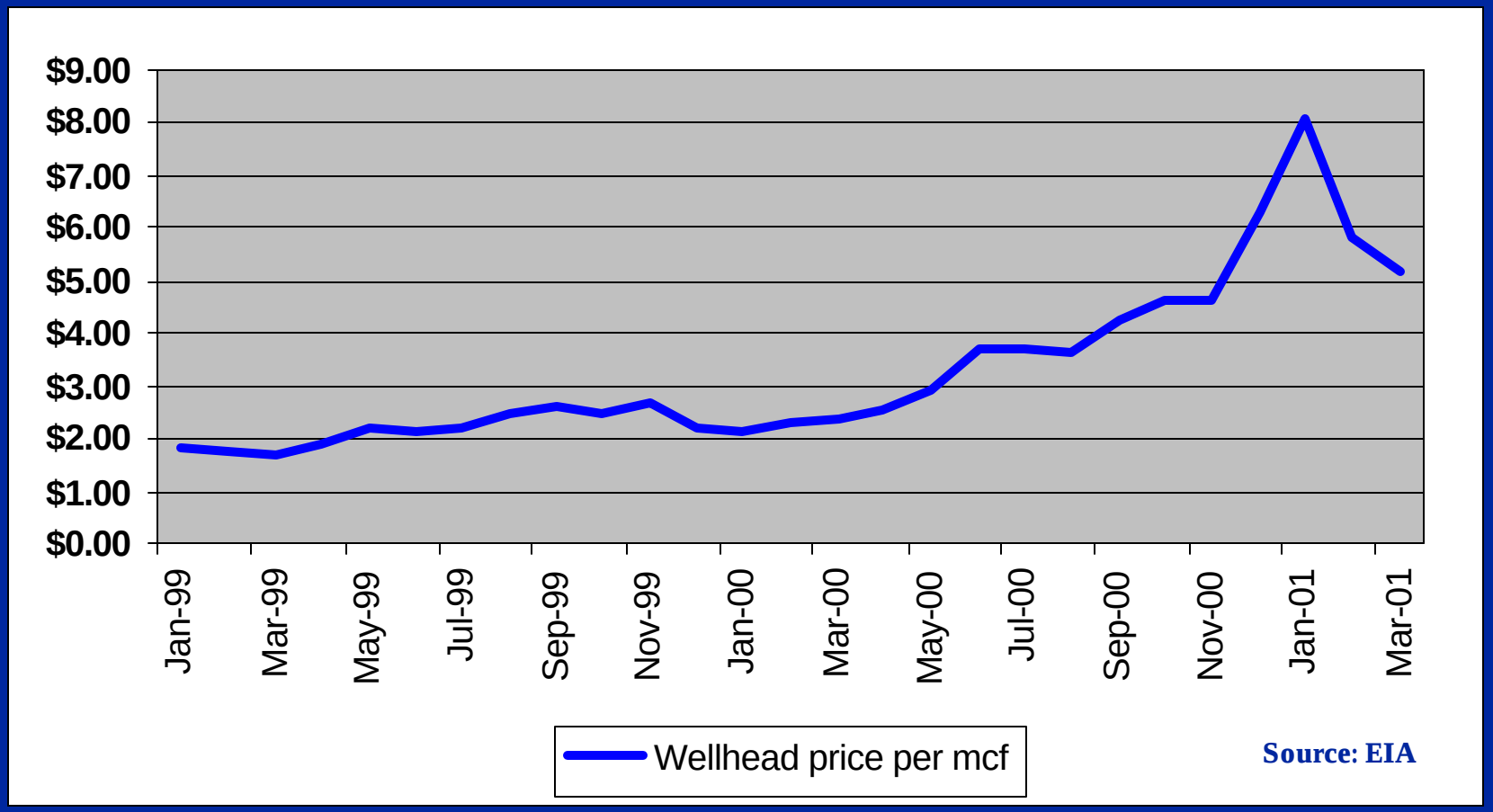
Source: EIA

Cost of Natural Gas Use at Plants

Natural Gas

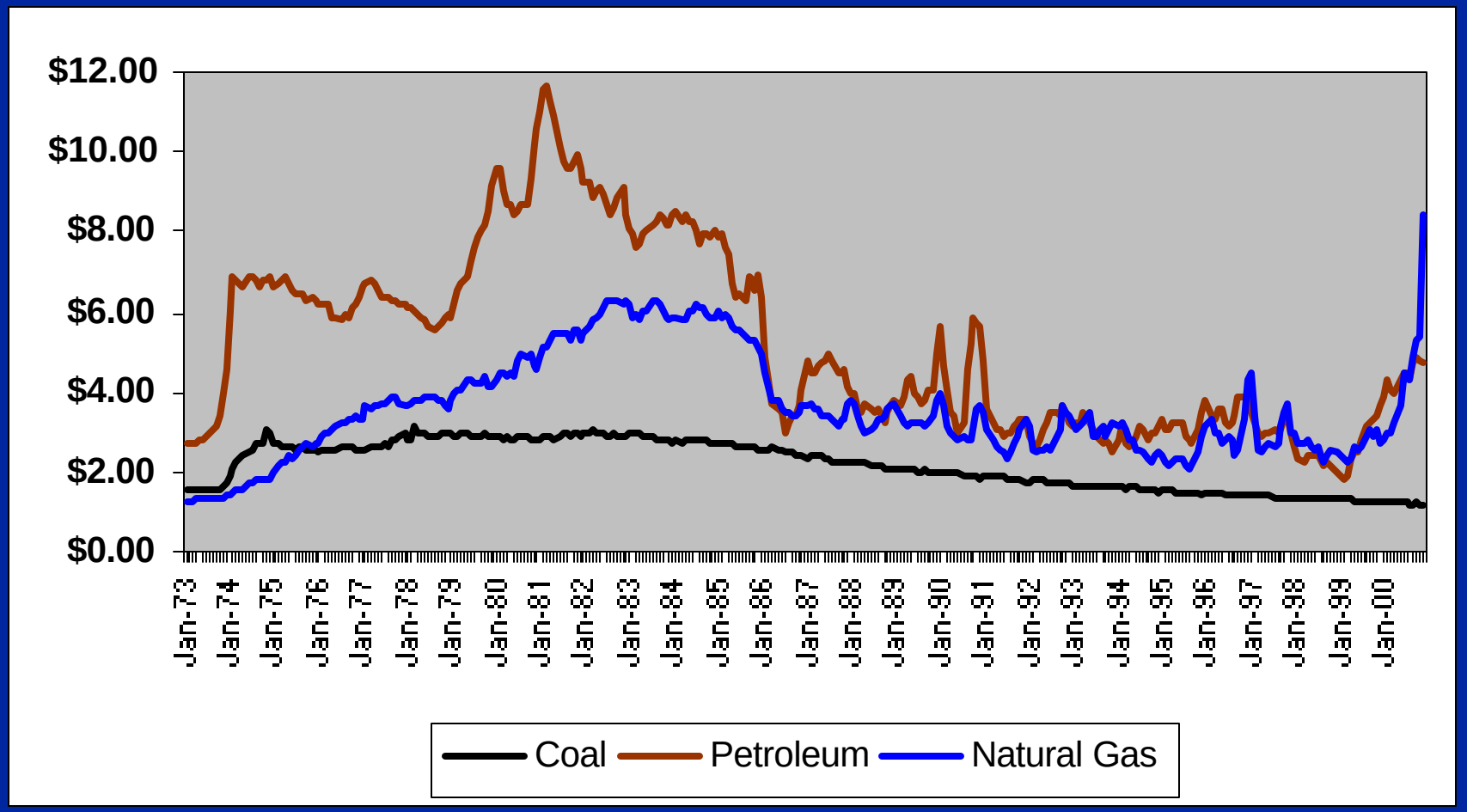


Recent Natural Gas Prices



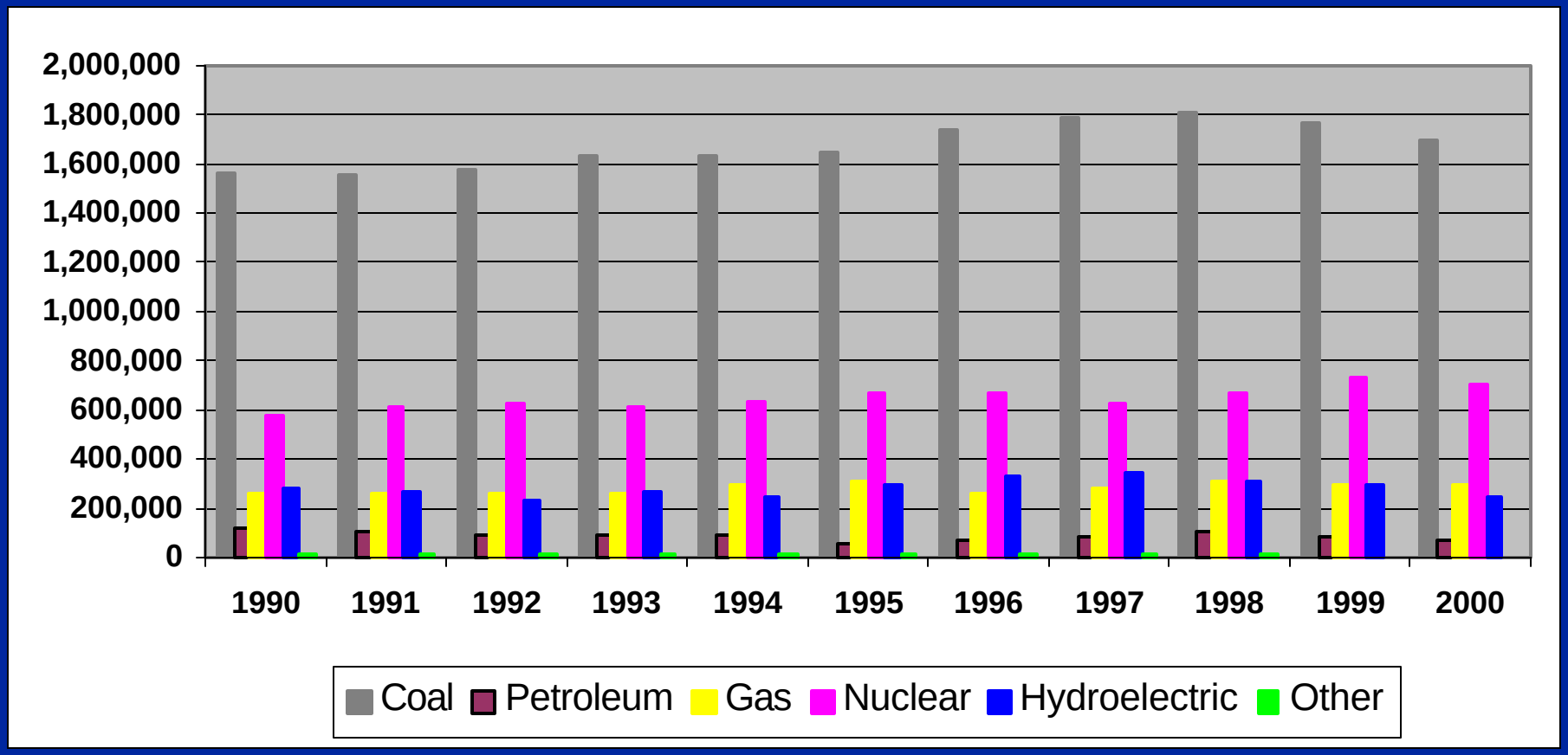
Source: EIA

Comparison of Fossil Fuel Costs

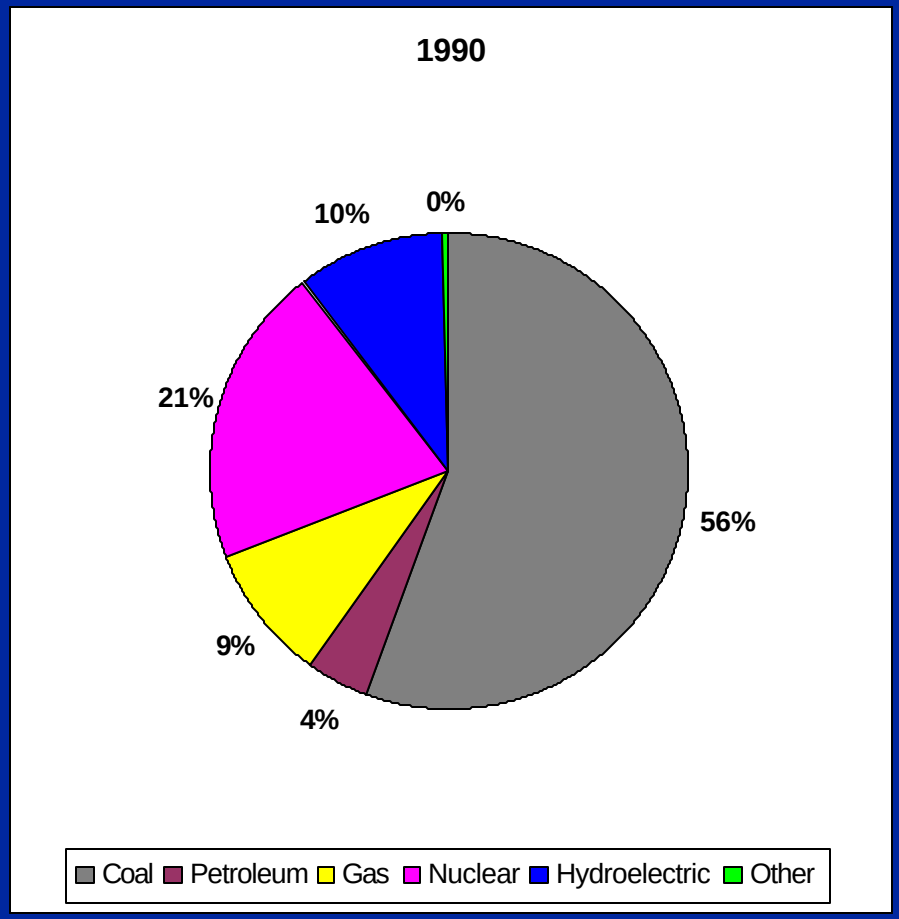


Net Generation

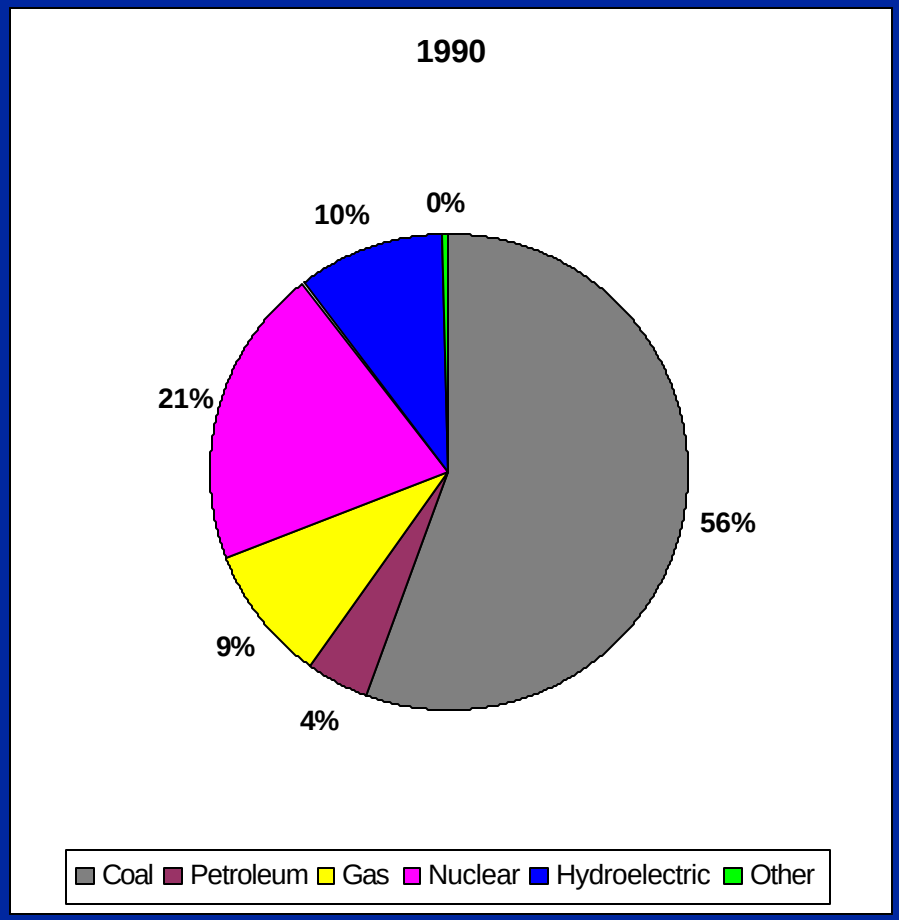
(millions of kwh)

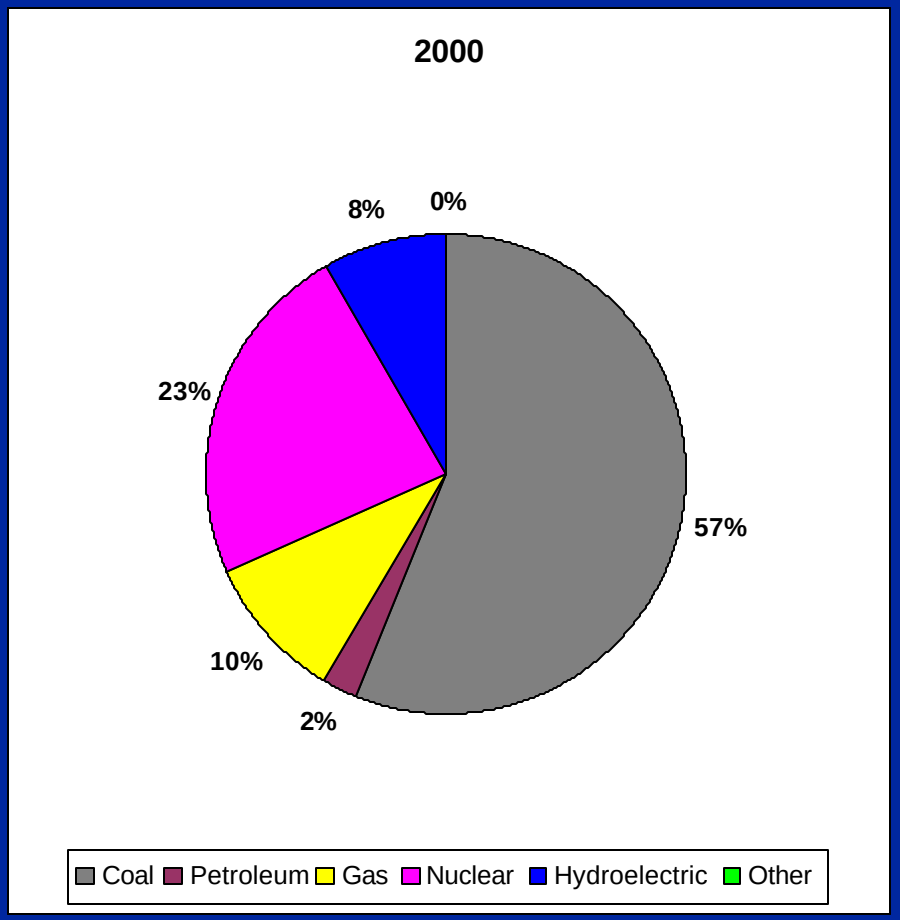


Electric Generation, 1990

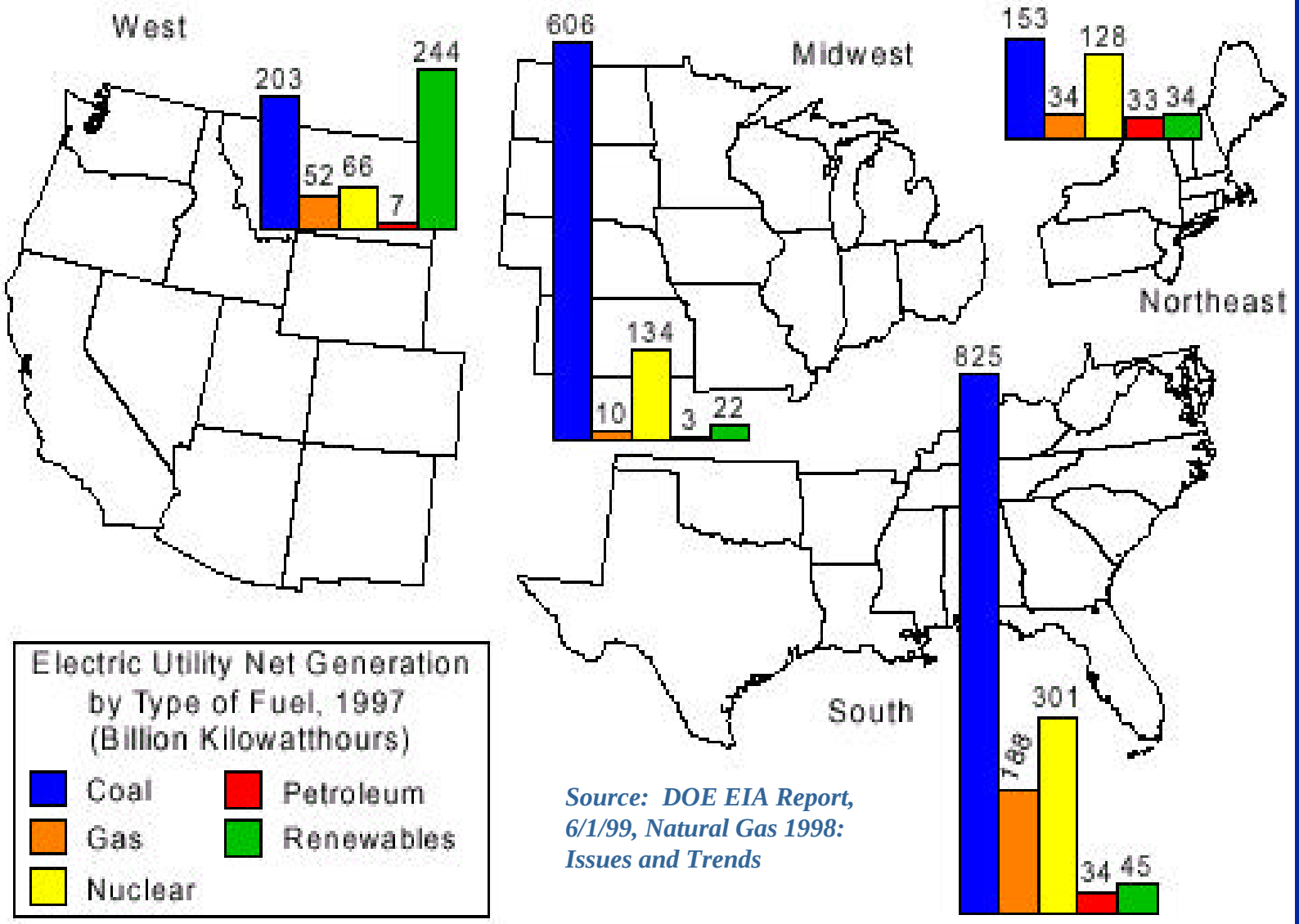


Electric Generation, 1990 & 2000



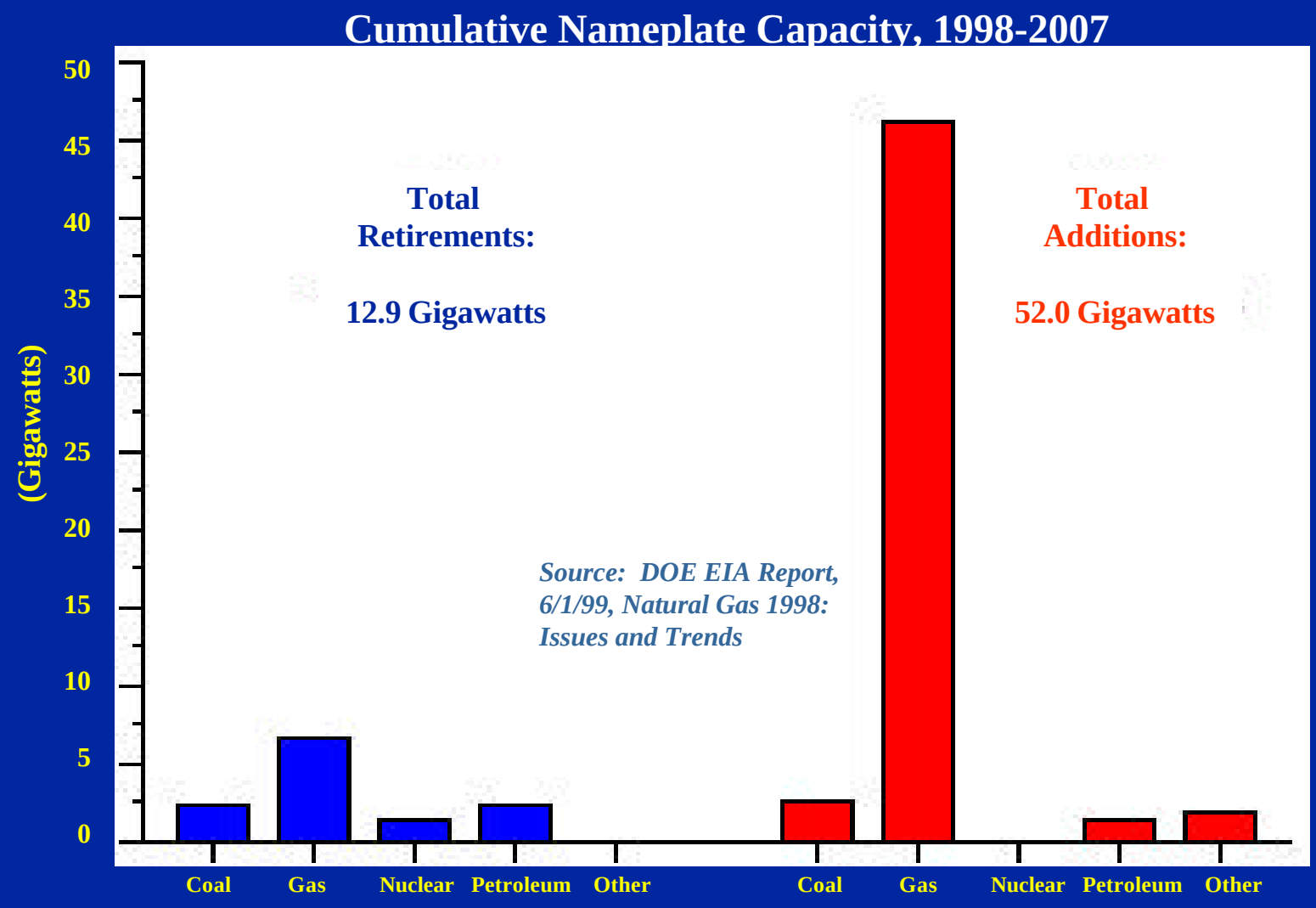


Regional Electric Mix by Fuel Type



Source: DOE EIA Report, 6/1/99, Natural Gas 1998: Issues and Trends

Most new electric capacity additions are being fueled by natural gas

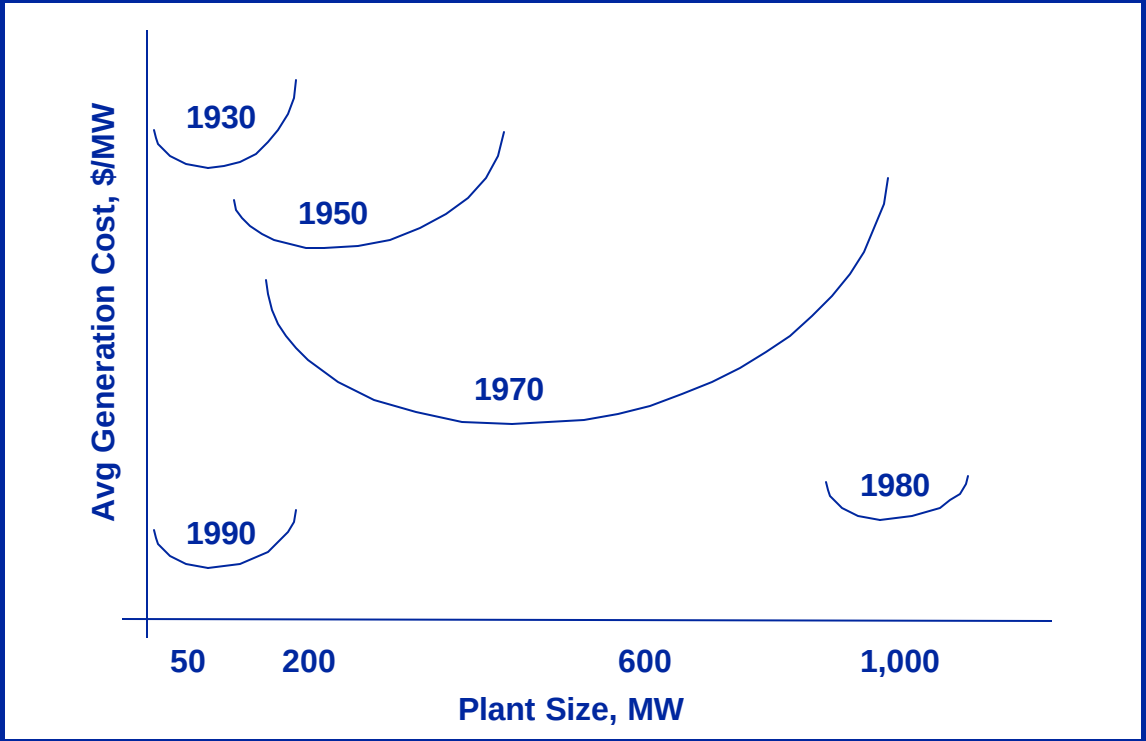


Fossil Fuel Use and Price Trends

- Coal is predominant base load fuel
- Coal prices have been declining since 1980s
- Oil use, generally for peaker and nonutility plants, has declined since 1970s
- Natural gas use, also for peaker plants, has been relatively stable until 2000
- Gas prices also stable until 2000

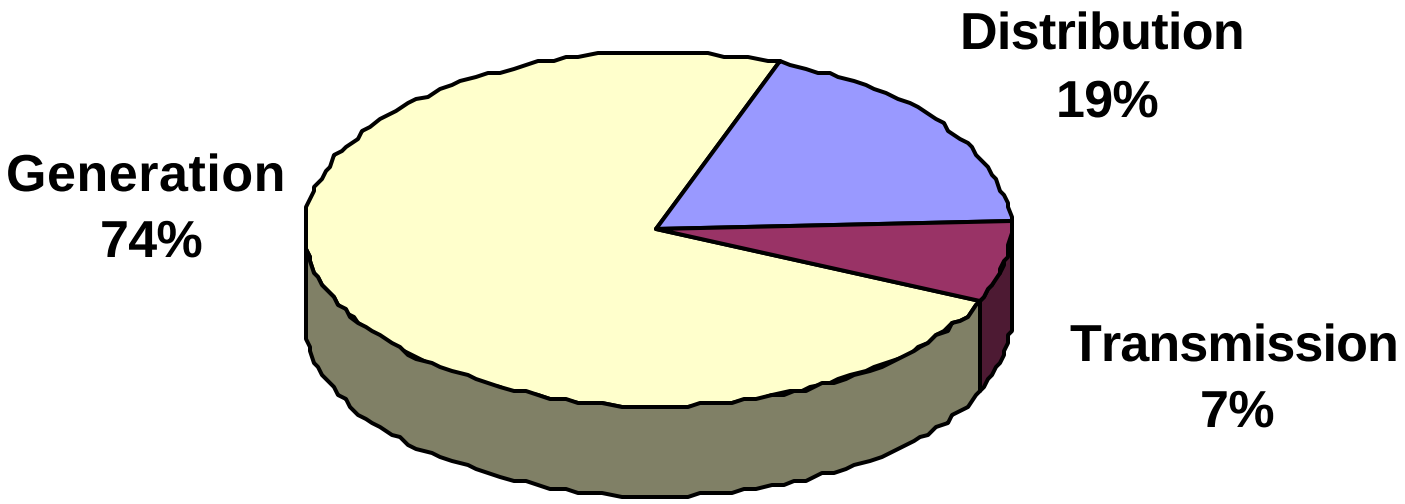
Optimum Size of Plants

- Development of Combustion Engines
- Low investment costs
- Low operations cost
- Until recently, availability of low-cost natural gas



Optimal generation plant size for a single plant based on cost per megawatt (MW), 1930-1990

Average Embedded Cost of U.S. Electricity by Function

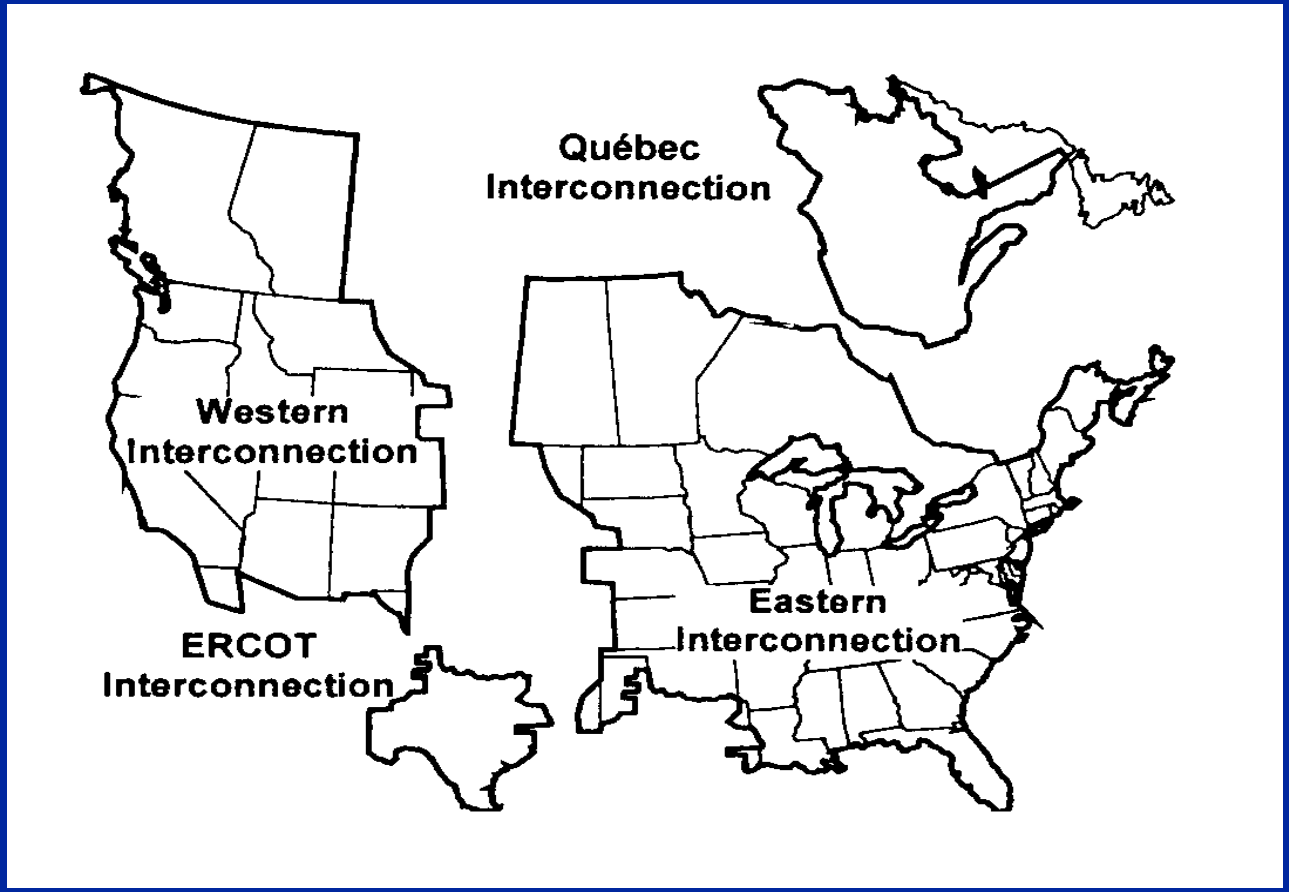


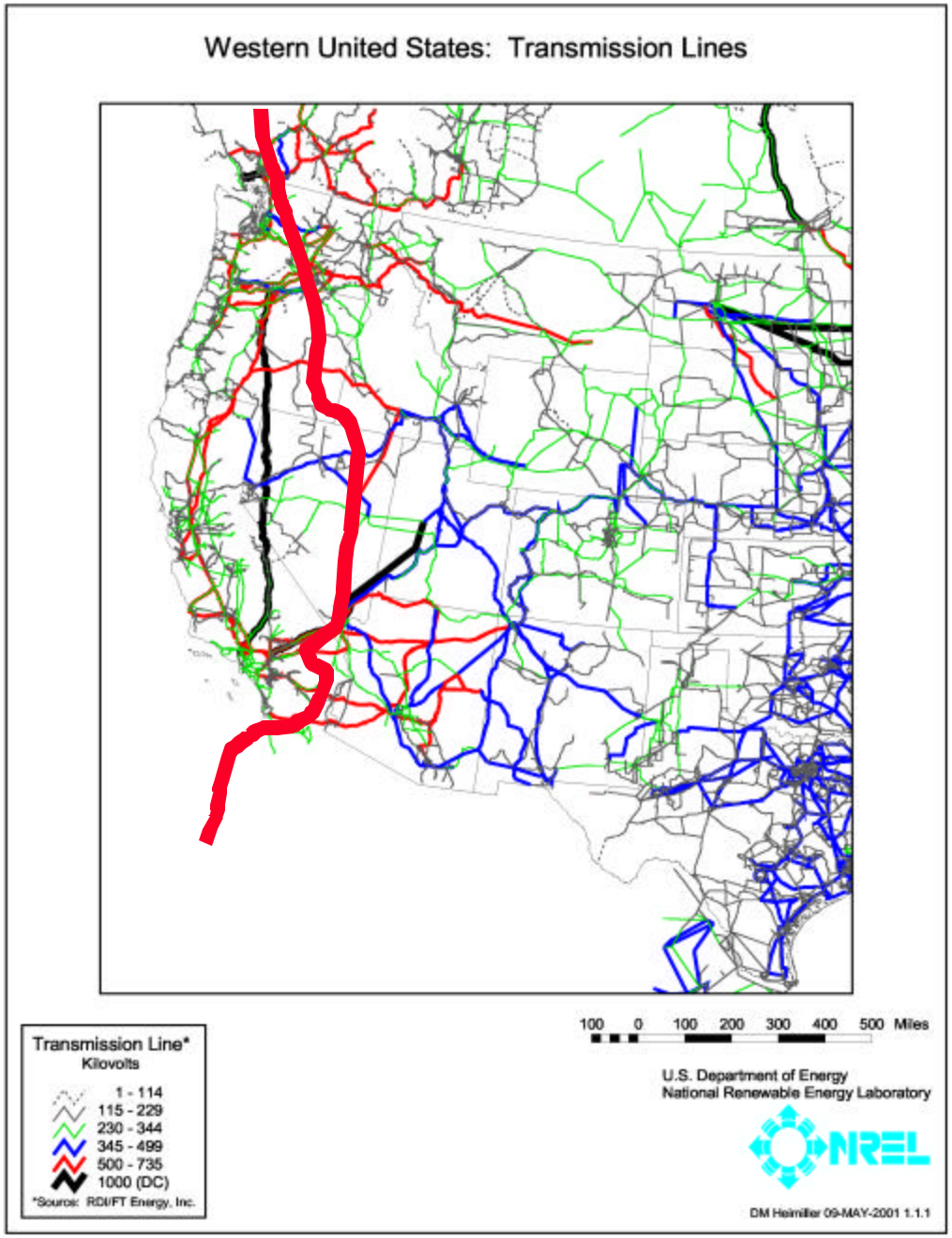
Source: USEIA. 1995

Lower prices for customers under restructuring should be expected to come from savings in generation costs.

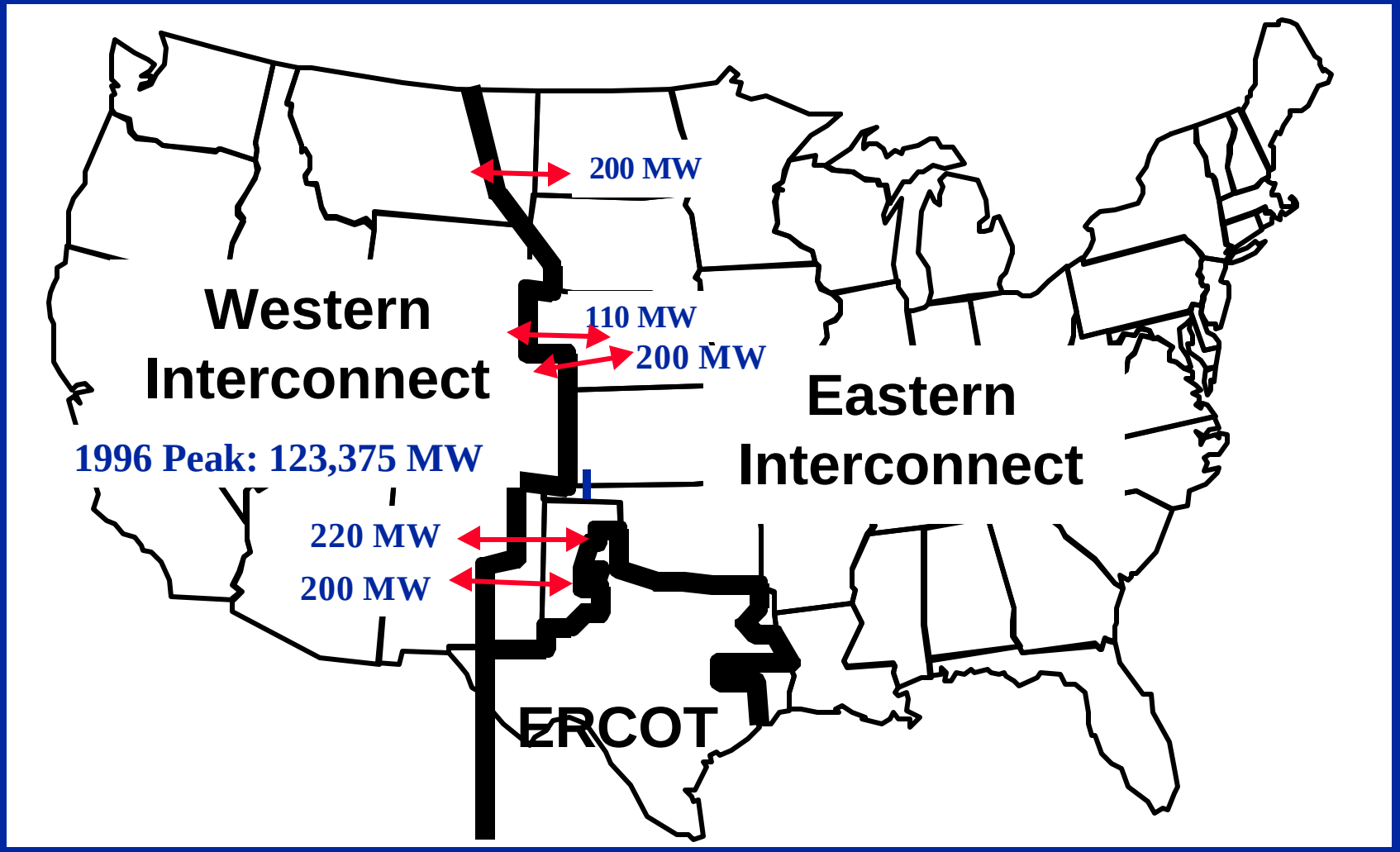
Transmission

Four North American Grids




Western United States: Transmission Lines
Transmission Line*
Kilovolts
1 - 114
115 - 229
230 - 344
345 - 499
500 - 735
1000 (DC)
*Source: RDI/FT Energy, Inc.
100 0 100 200 300 400 500 Miles
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
DM Heimiller 09-MAY-2001 1.1.1

Three "Separate" U.S. Electric Grids



- 60 Hertz frequencies are slightly different between the grids
- Less than 1% of the W. Interconnection can come from, or go to, the East
- Three separate electric markets

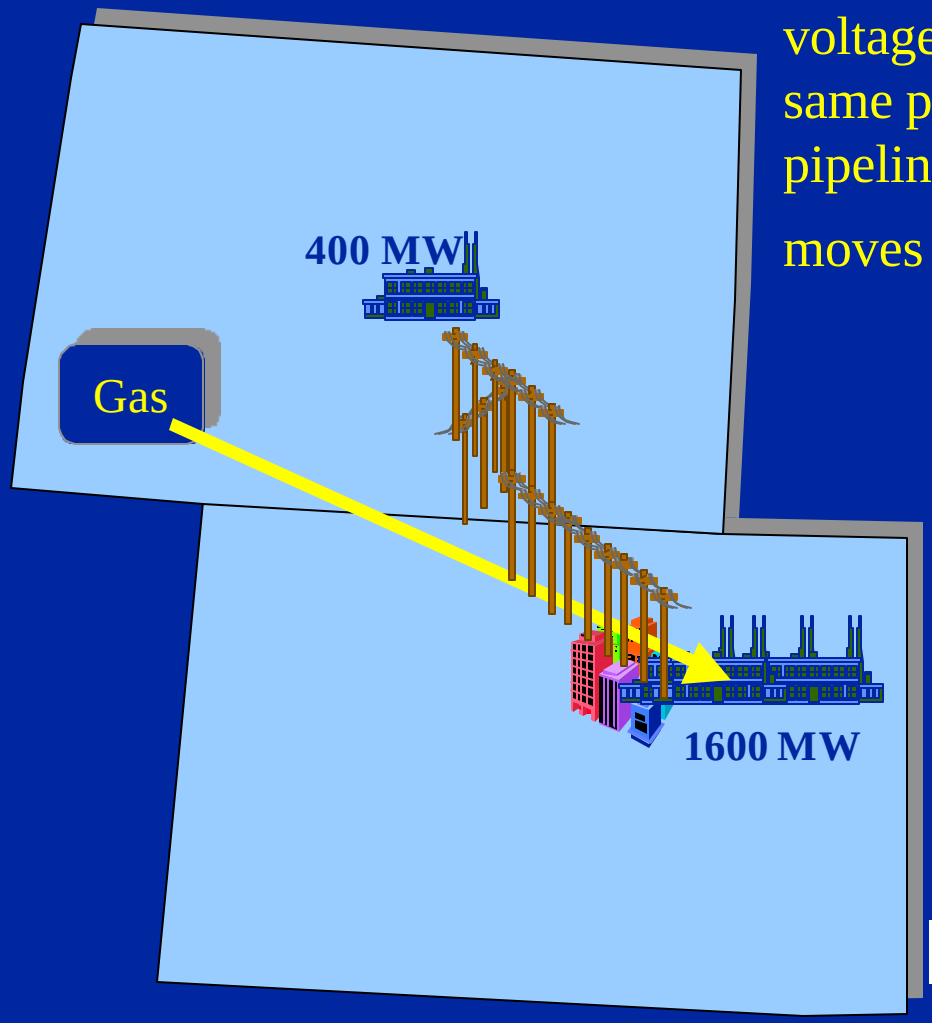
Pipeline

A 300 mile 24” gas pipeline transports 250 MMcf/day, the energy equivalent of **3200 MW,** which is equivalent to the energy to fuel **1600 MW** of Combined Cycle power

versus

Transmission Line

A 300 mile 345kv high voltage line, at about the same price as the 24” pipeline ($.5M/mile), moves only **400 MW**



Source: COPUC

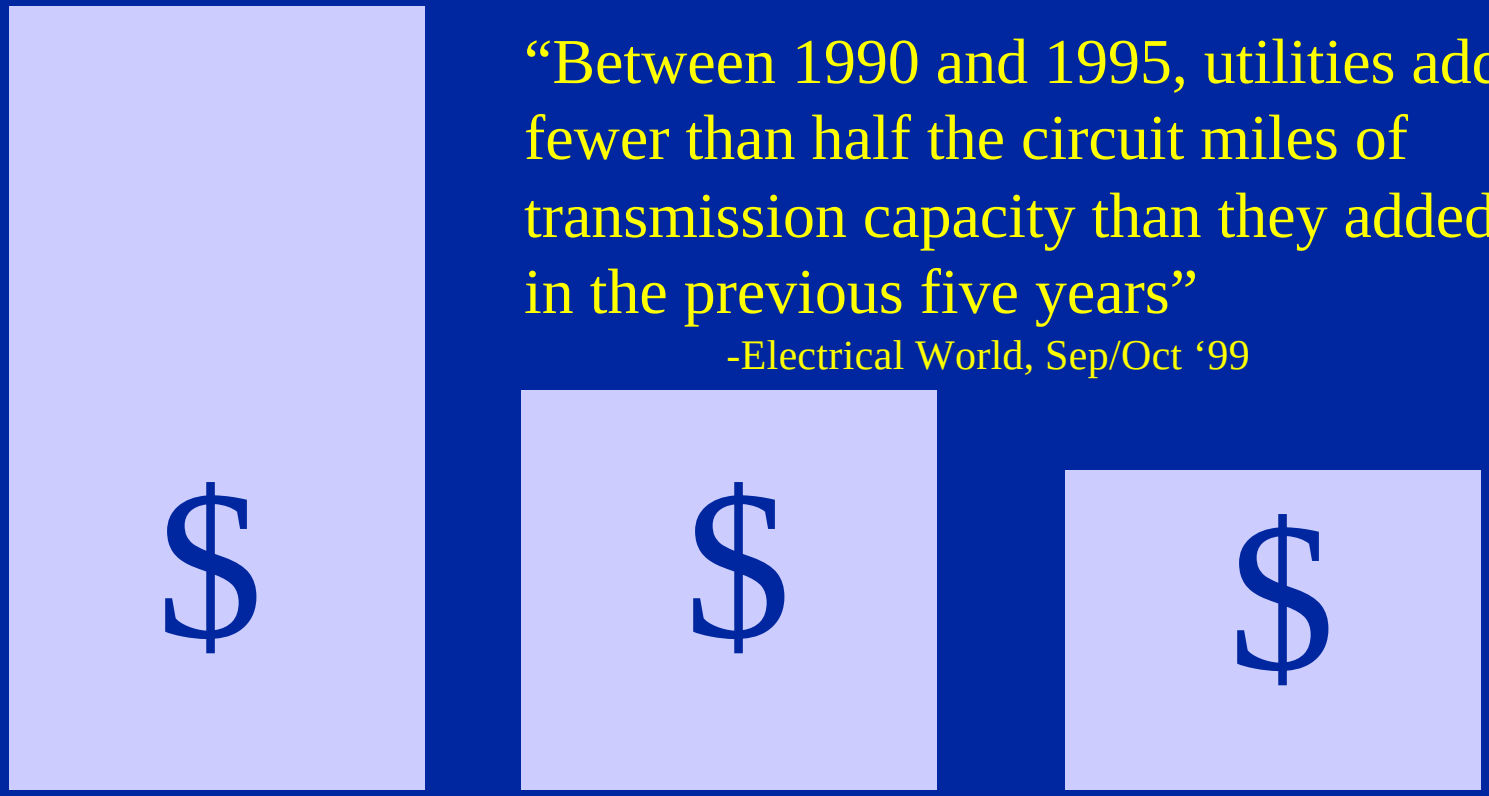
Interstate Gas Pipelines:
Federal government exercises authority that requires landowners to yield.

Electric Transmission Lines: Utilities must fight NIMBY on either a county-by-county basis, or less often, on a state siting council basis.
(National Energy Plan proposes to change this.)

Utility investment in transmission

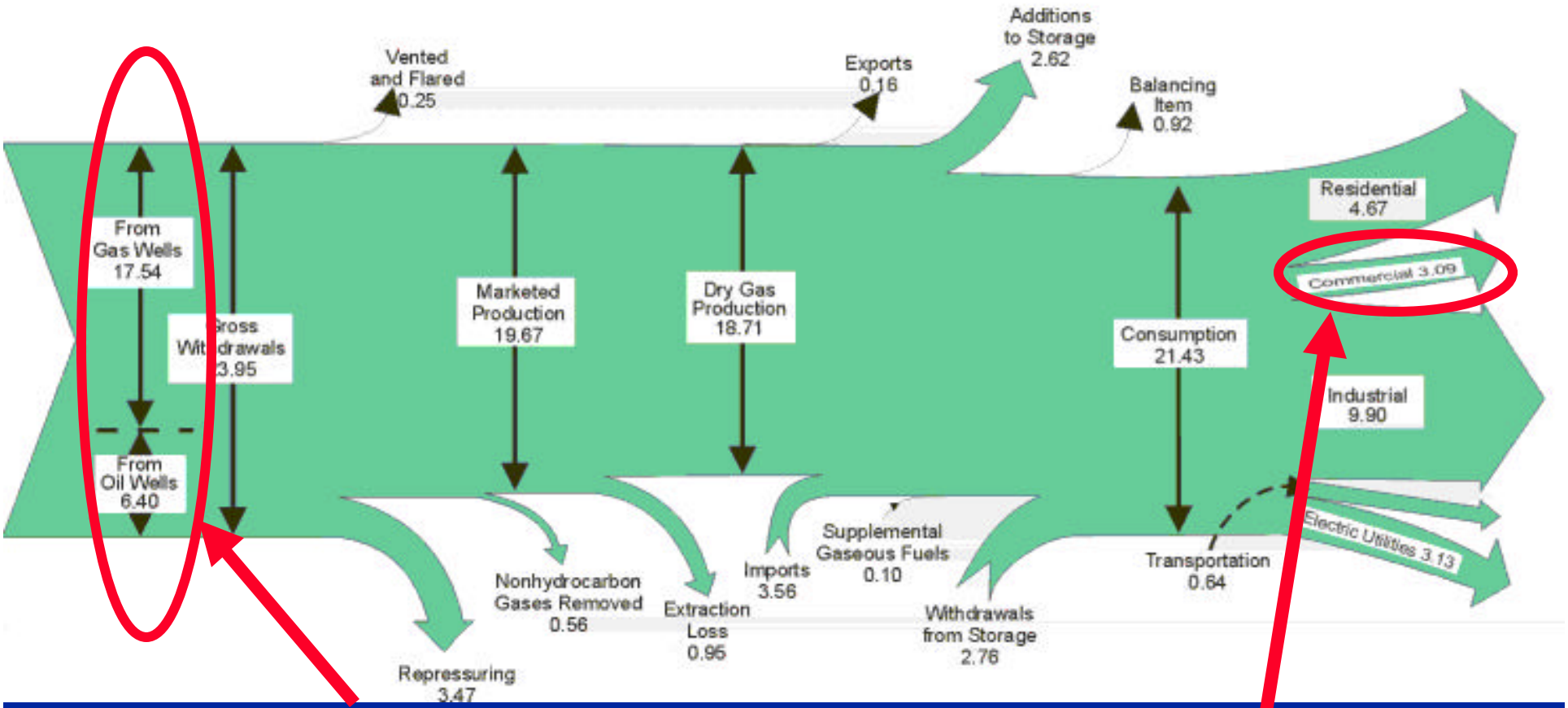
"Between 1990 and 1995, utilities added fewer than half the circuit miles of transmission capacity than they added in the previous five years"

-Electrical World, Sep/Oct '99



Source: Cambridge Energy Research Associates

Natural Gas



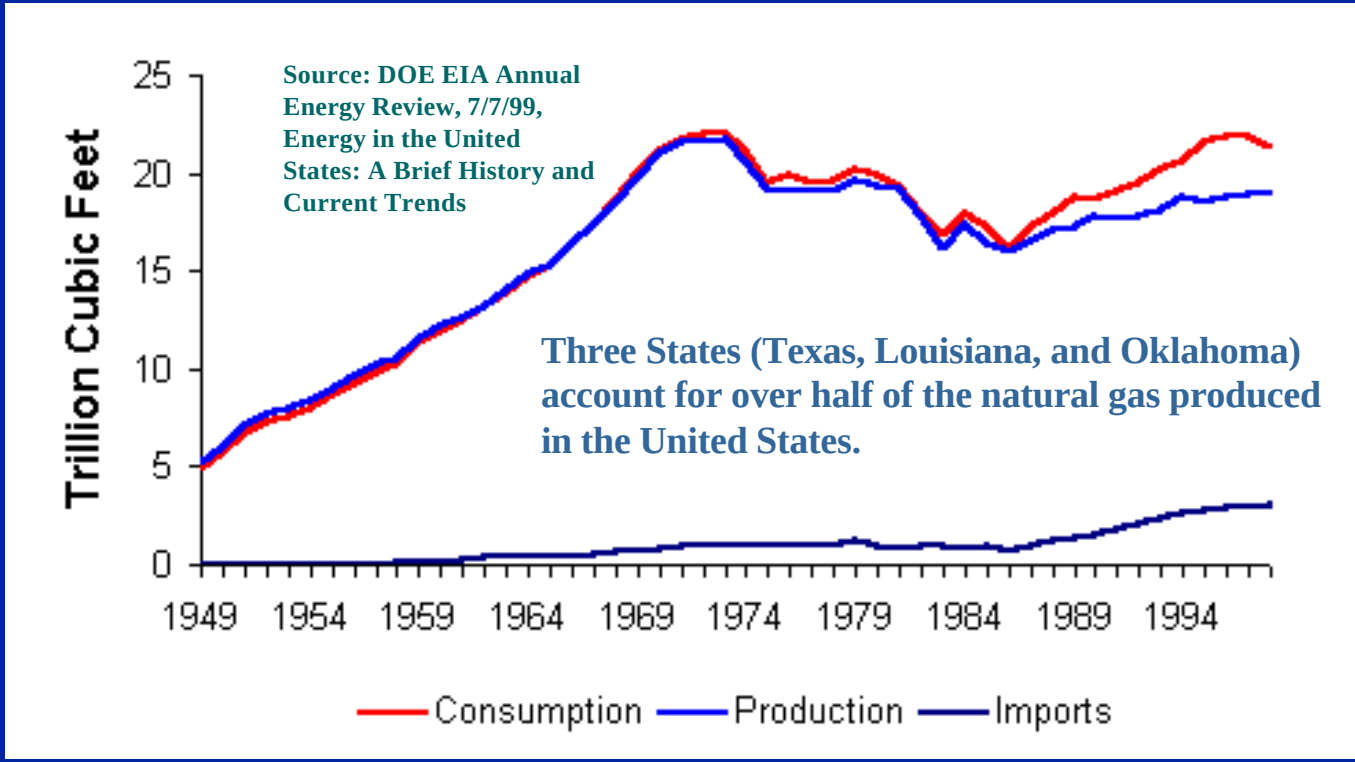
Gas Prices Not Decoupled from Oil

Commercial customers get few price breaks

Why did natural gas prices surge in 2000?

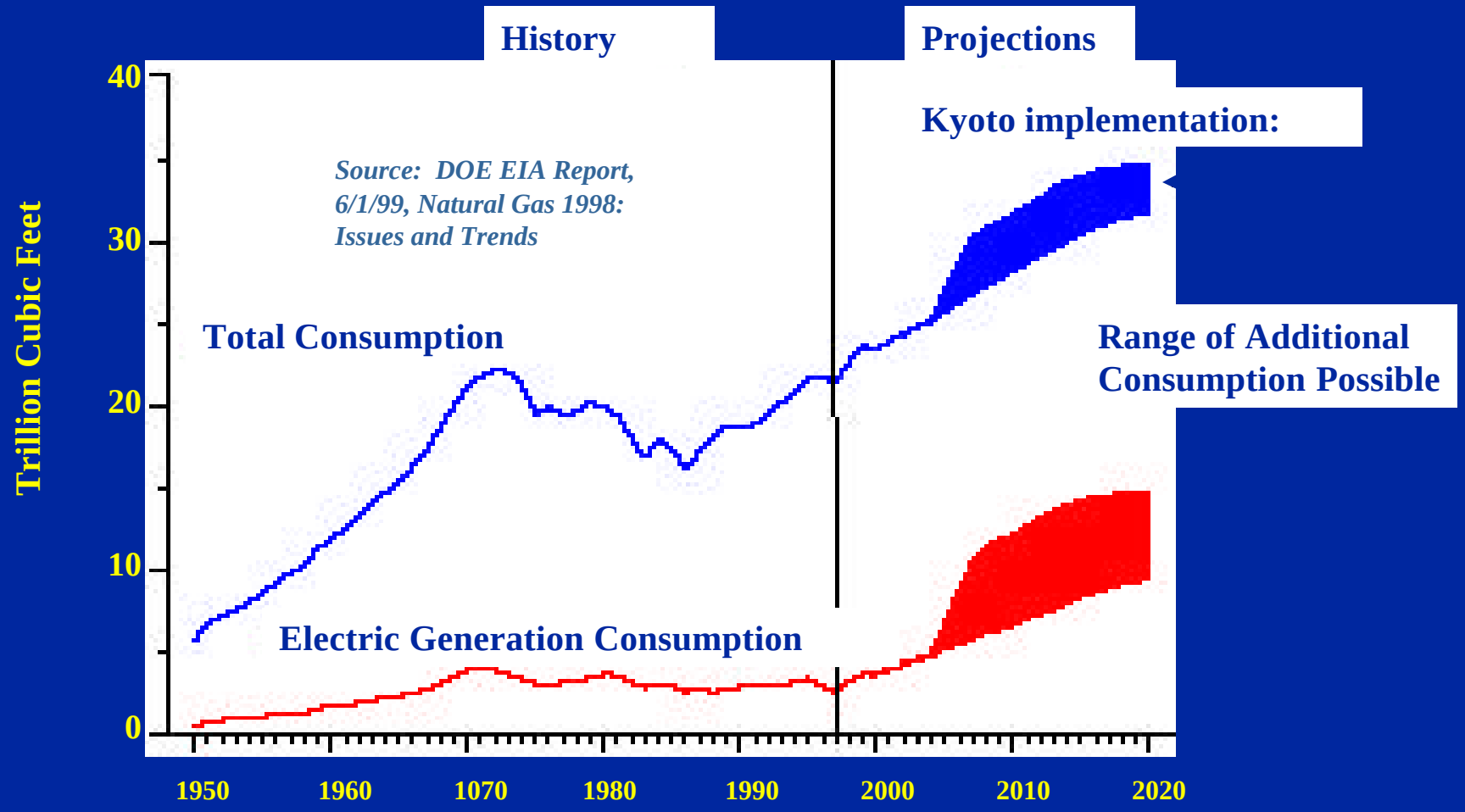
- Supply tightness
  - Fewer rigs operated in 1998 and 1999
- Storage Stocks - lower than average
  - Used for gas-fired generation
- Consumption increases
  - Robust Economy
- Oil Price Increases
- Weather

Natural Gas Production Vs. Consumption

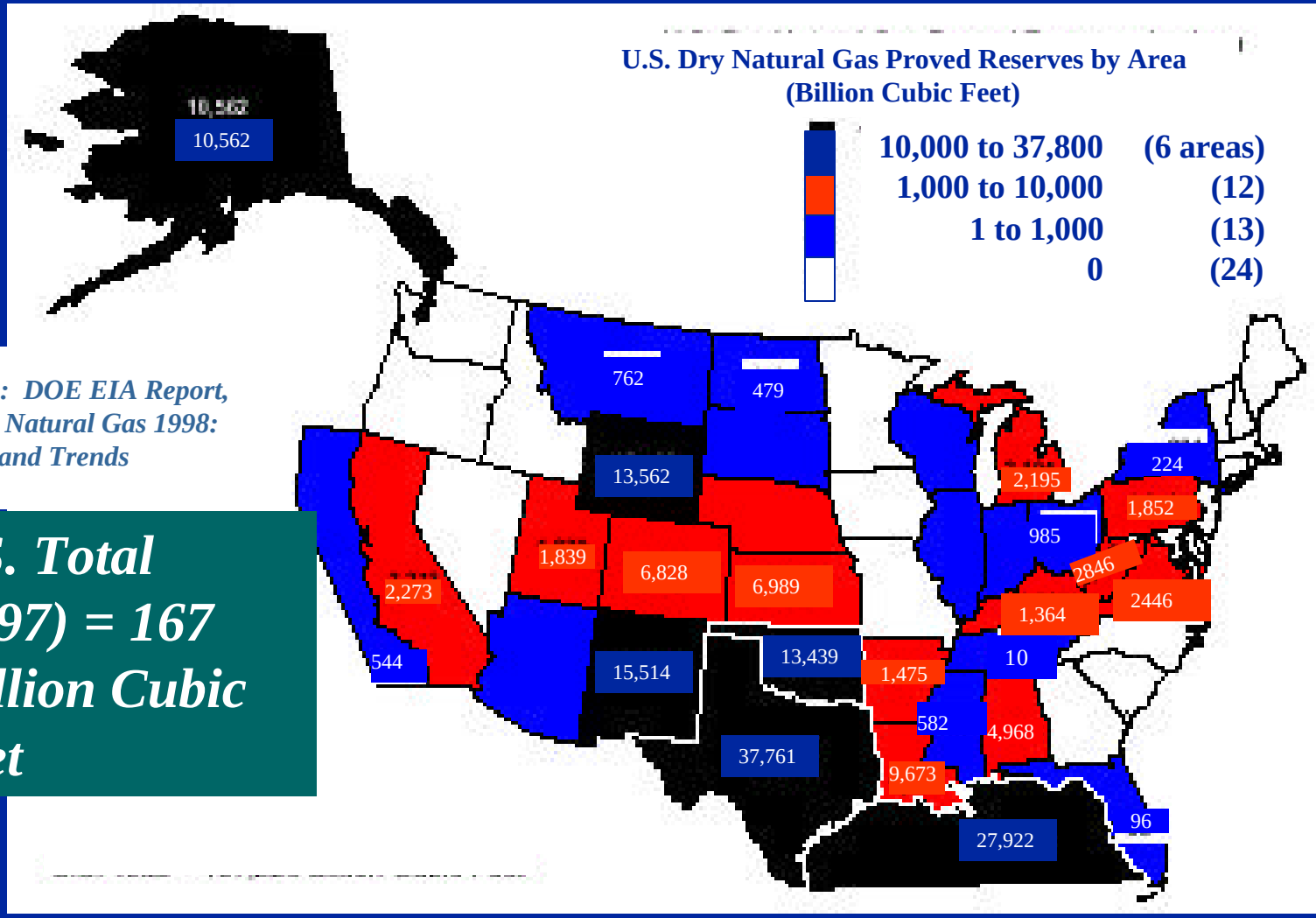


The United States had large natural-gas reserves and was essentially self-sufficient in natural gas until the late 1980s, when consumption began to significantly outpace production.

Natural gas consumption is expected to increase about 50% by 2020, and even more if the Kyoto Protocol is implemented.



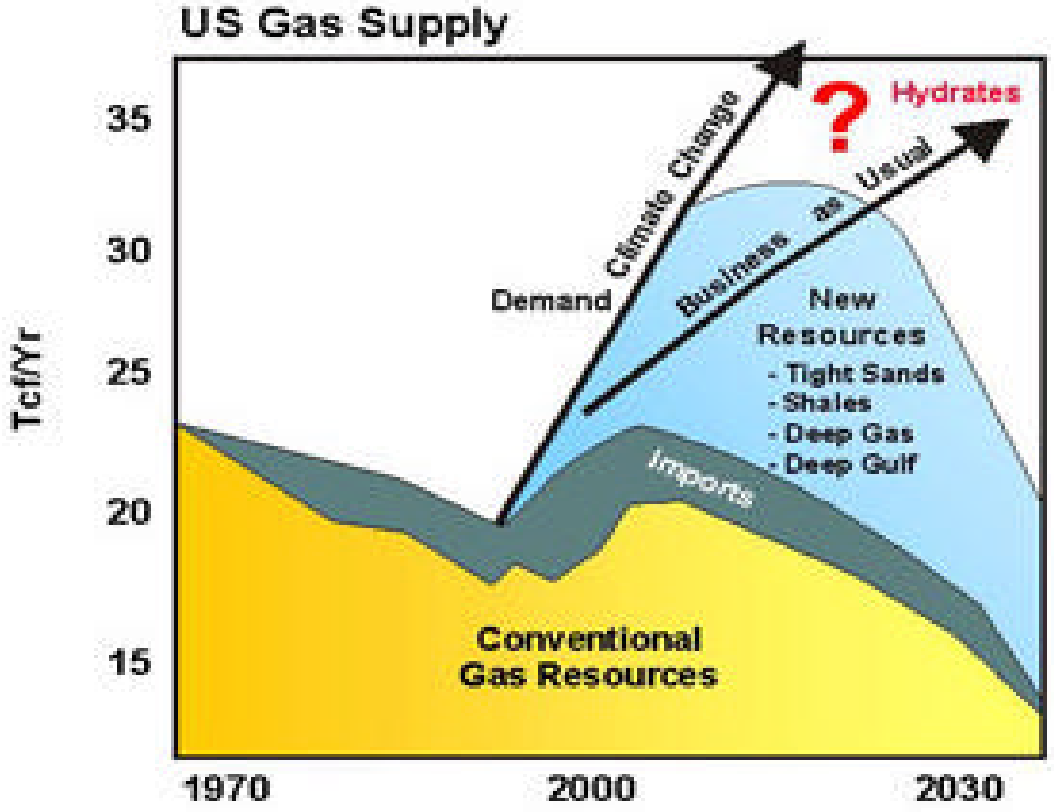
Proved U.S. reserves of natural gas are sufficient for about a decade at present rate of consumption



Source: DOE EIA Report, 6/1/99, Natural Gas 1998: Issues and Trends

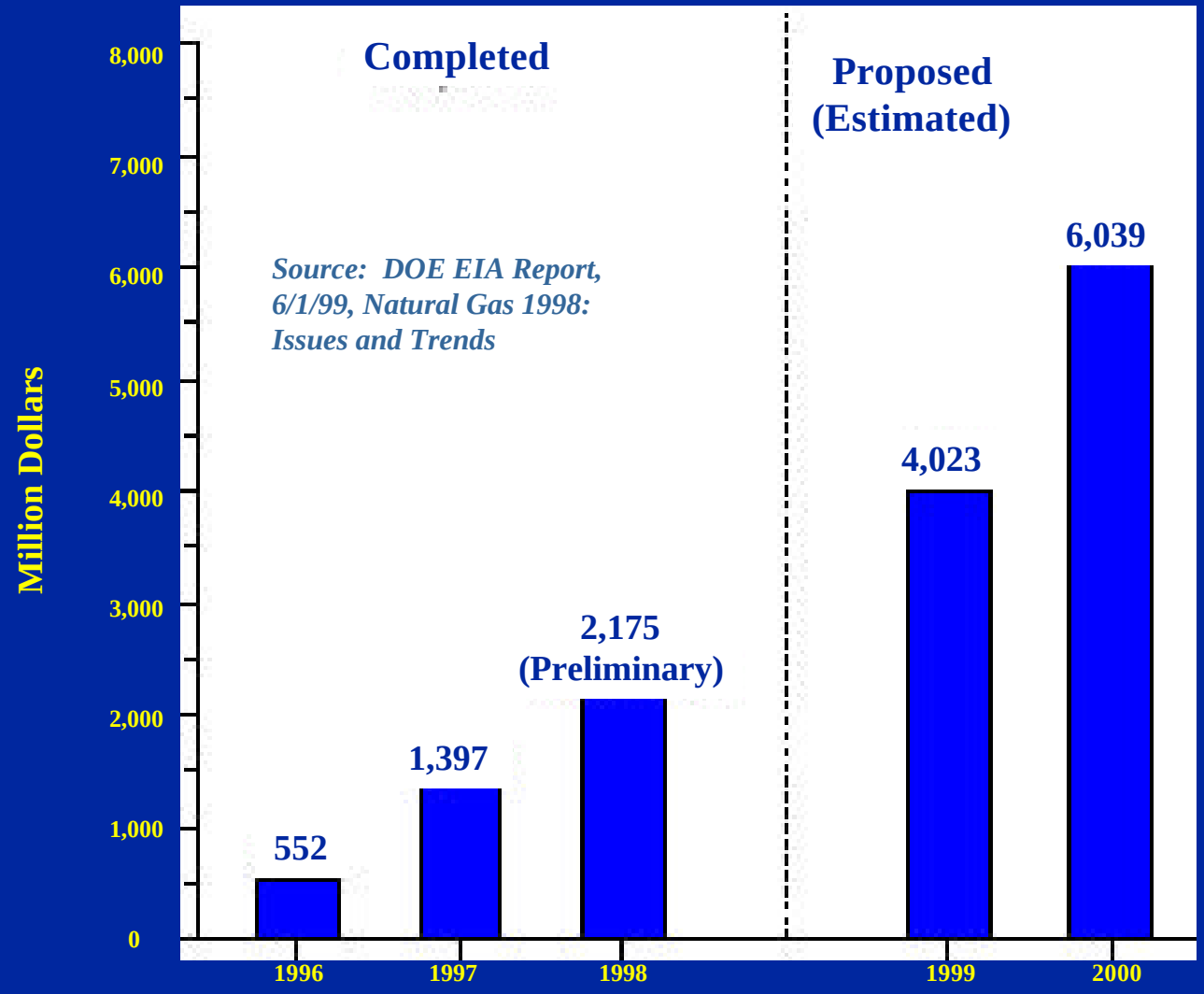
U.S. Total (1997) = 167 Trillion Cubic Feet

The long term outlook for domestic natural gas supplies contains uncertainties that will have cost implications.

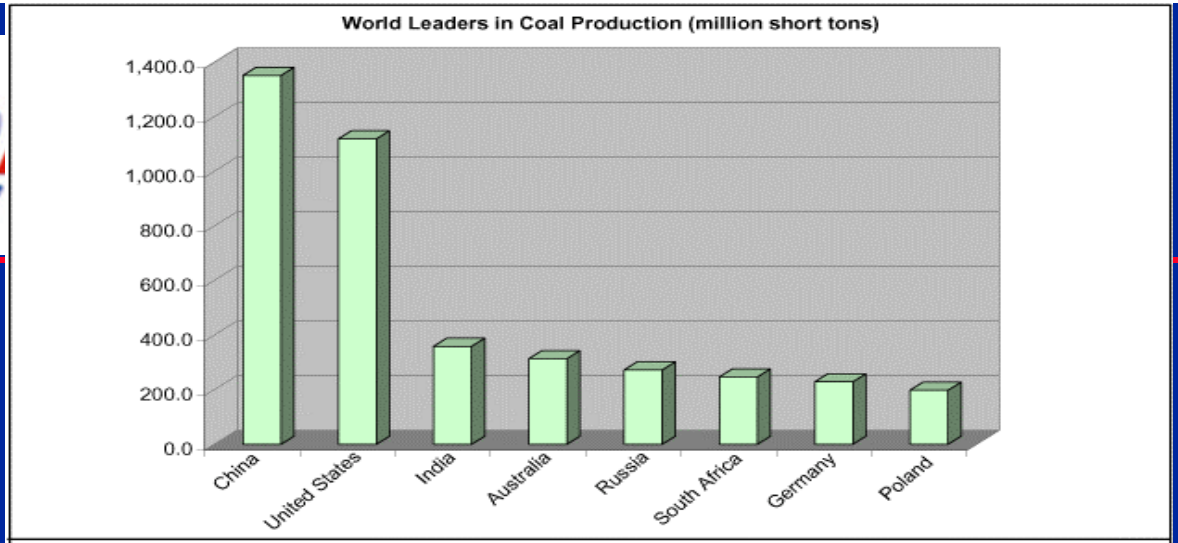


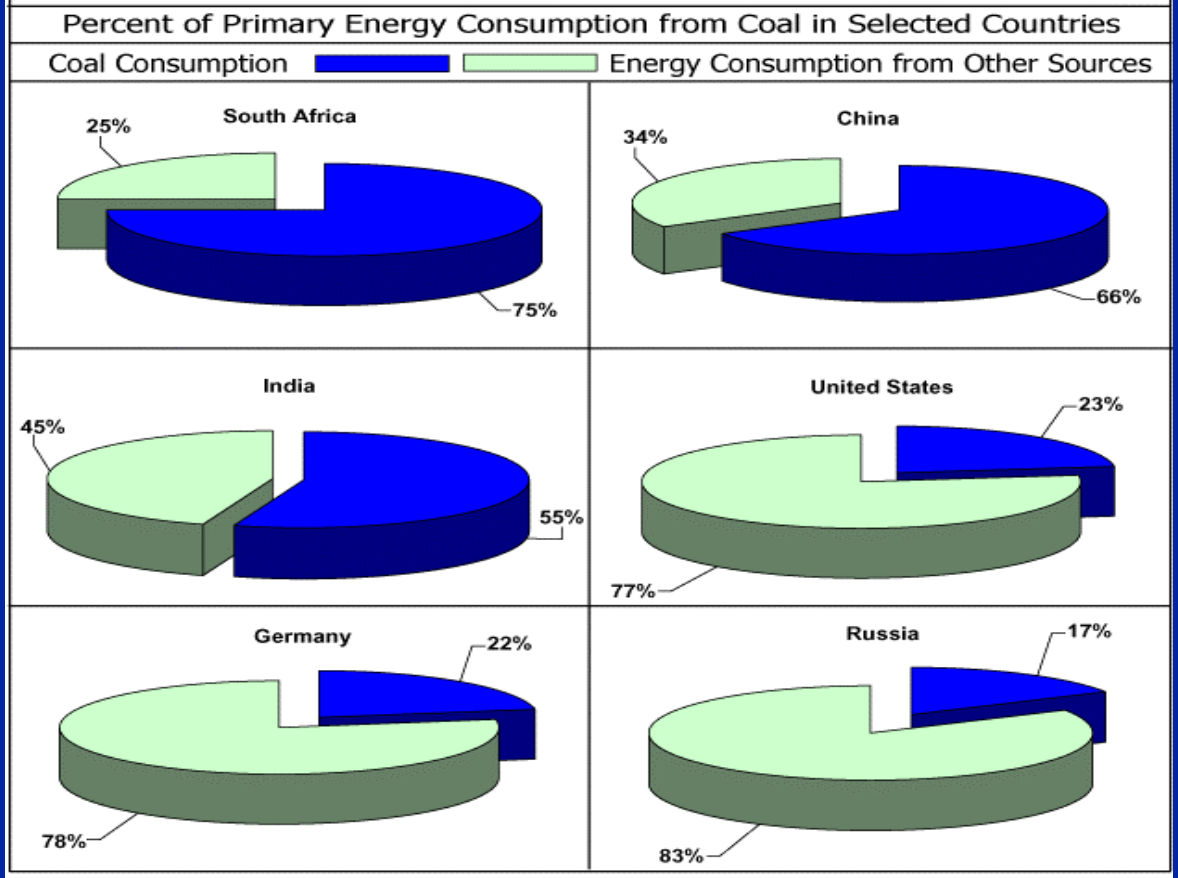
Source: DOE National Energy Technology Laboratory Strategic Center for Natural Gas website: http://www.fetc.doe.gov/

Annual pipeline investment reached $6 billion in 2000 - a substantial increase



Coal





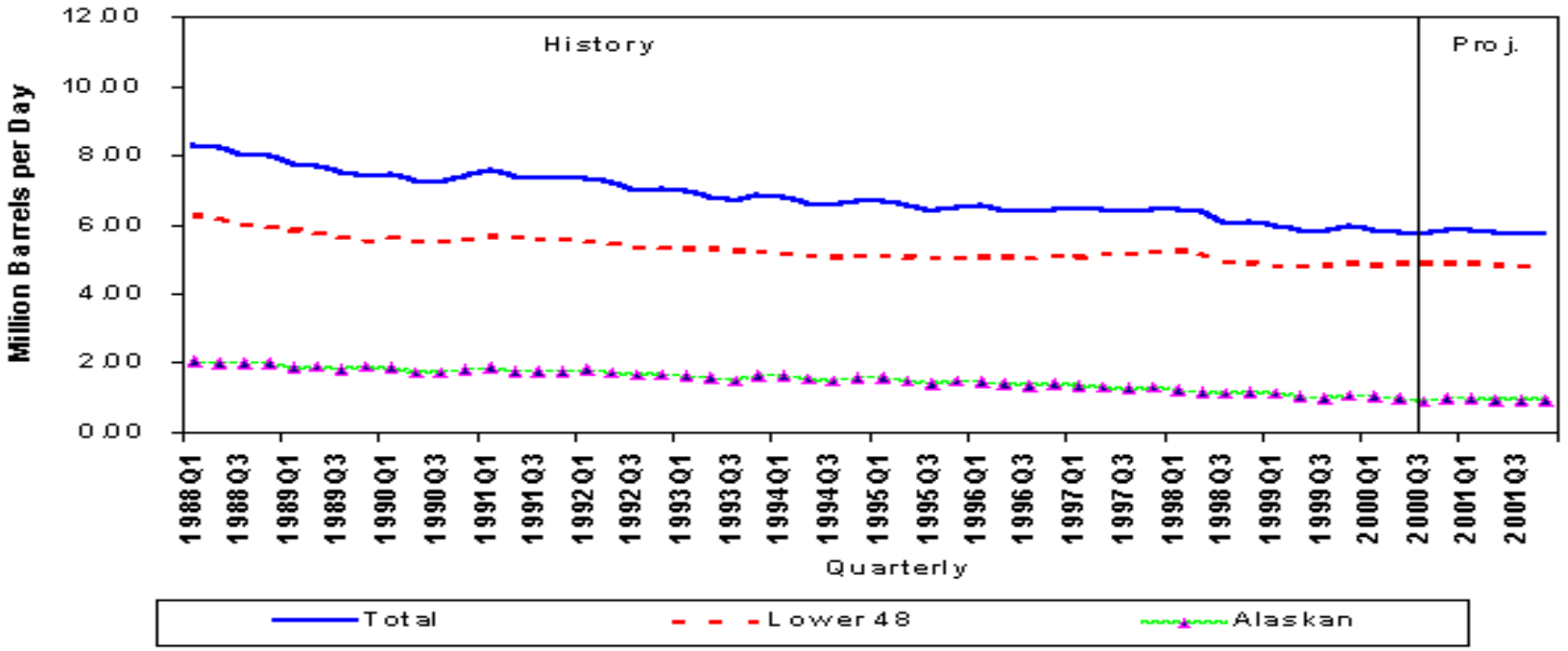
Source: Figures are for1998 from the Energy Information Administration, International Energy Database, December 1999.

Coal is King,
Can the King solve the carbon problem?

The industry and the DOE are investigating the potential of Zero Emission Coal

Petroleum

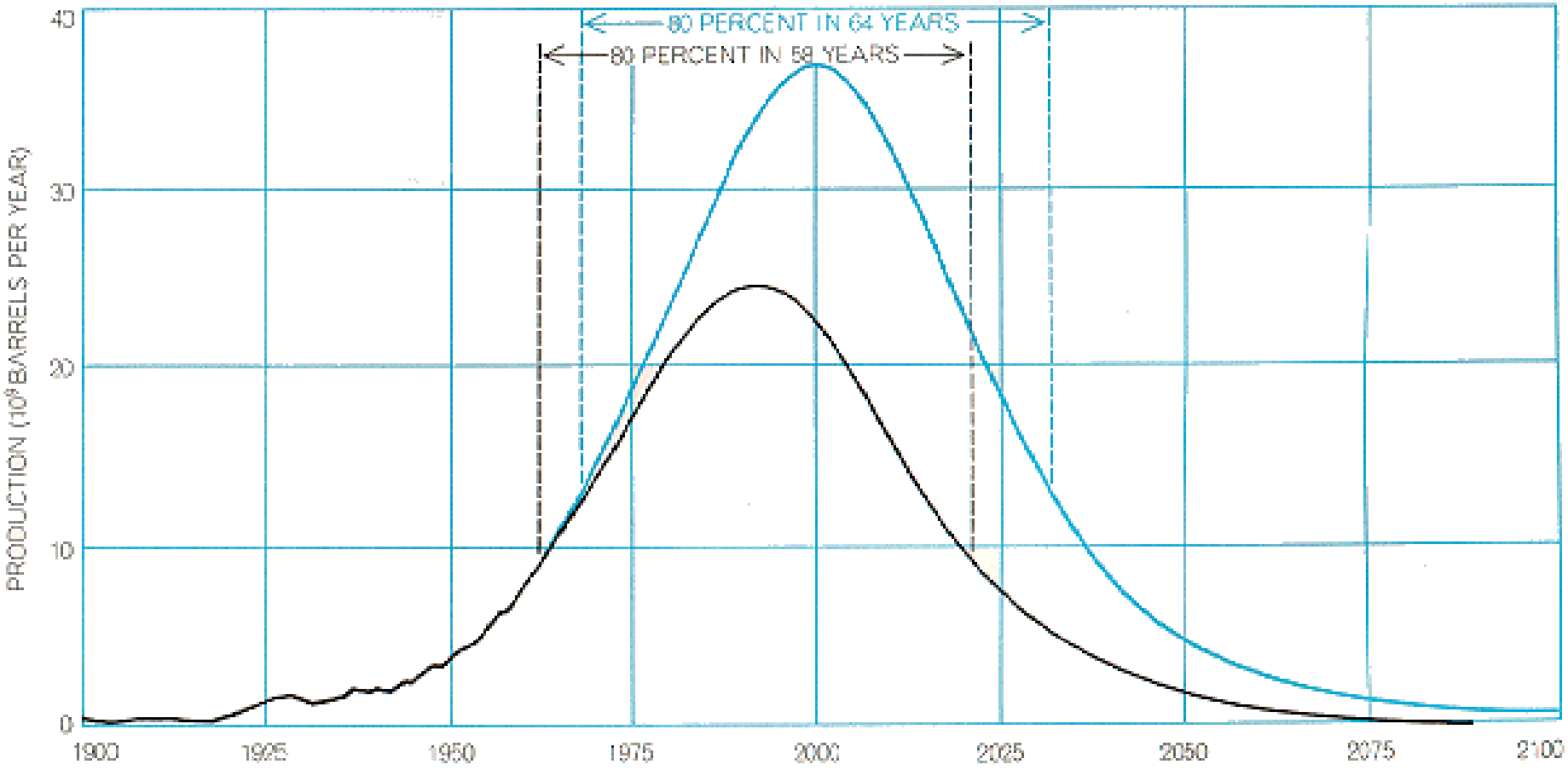
U.S. Crude Oil Production



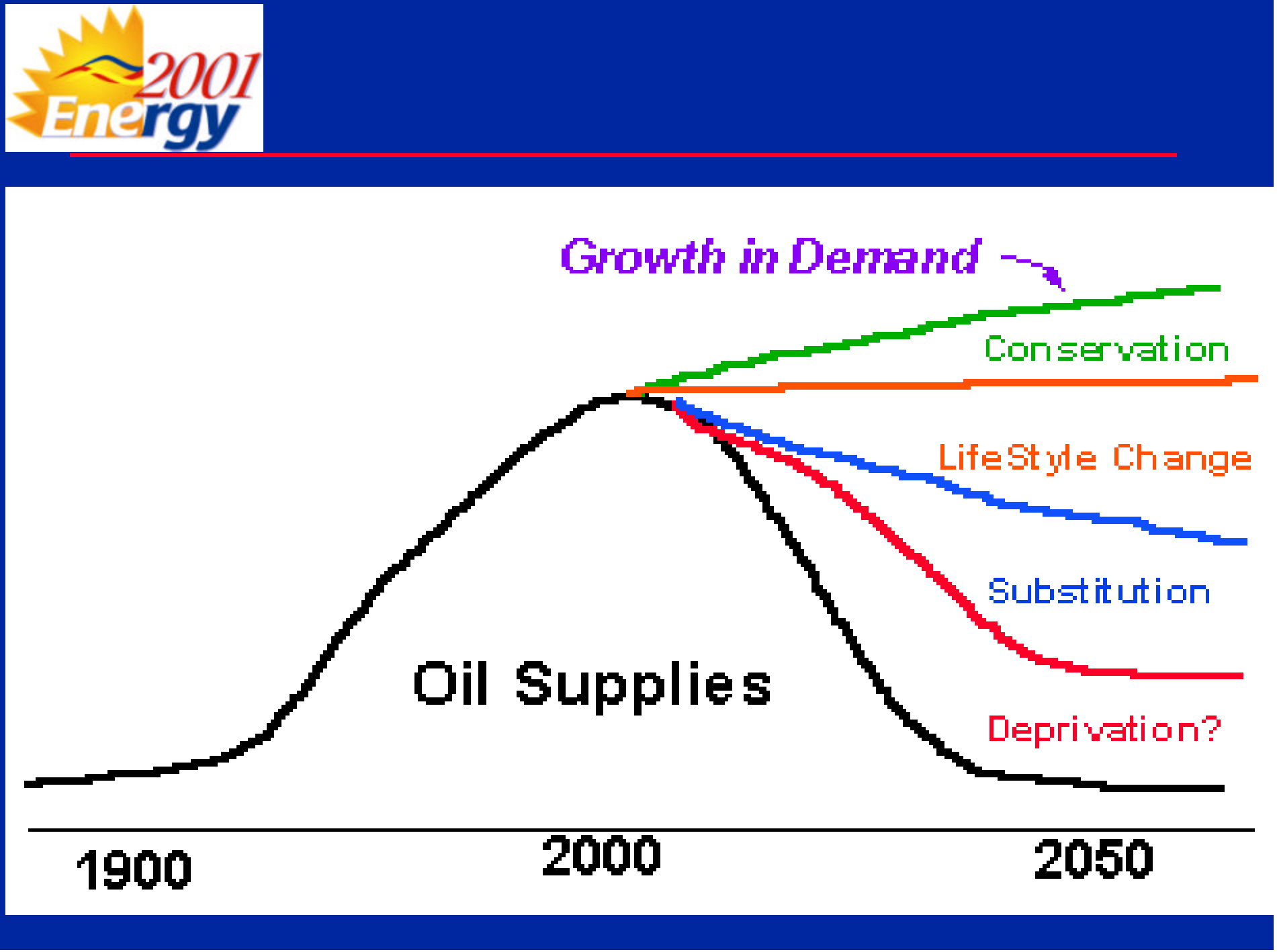
Sources: History: EIA; Projections: Short-Term Energy Outlook, August 2000.

www.eia.doe.gov

Depletion: Oil's Central Reality. Comparing the Bears to the Bulls

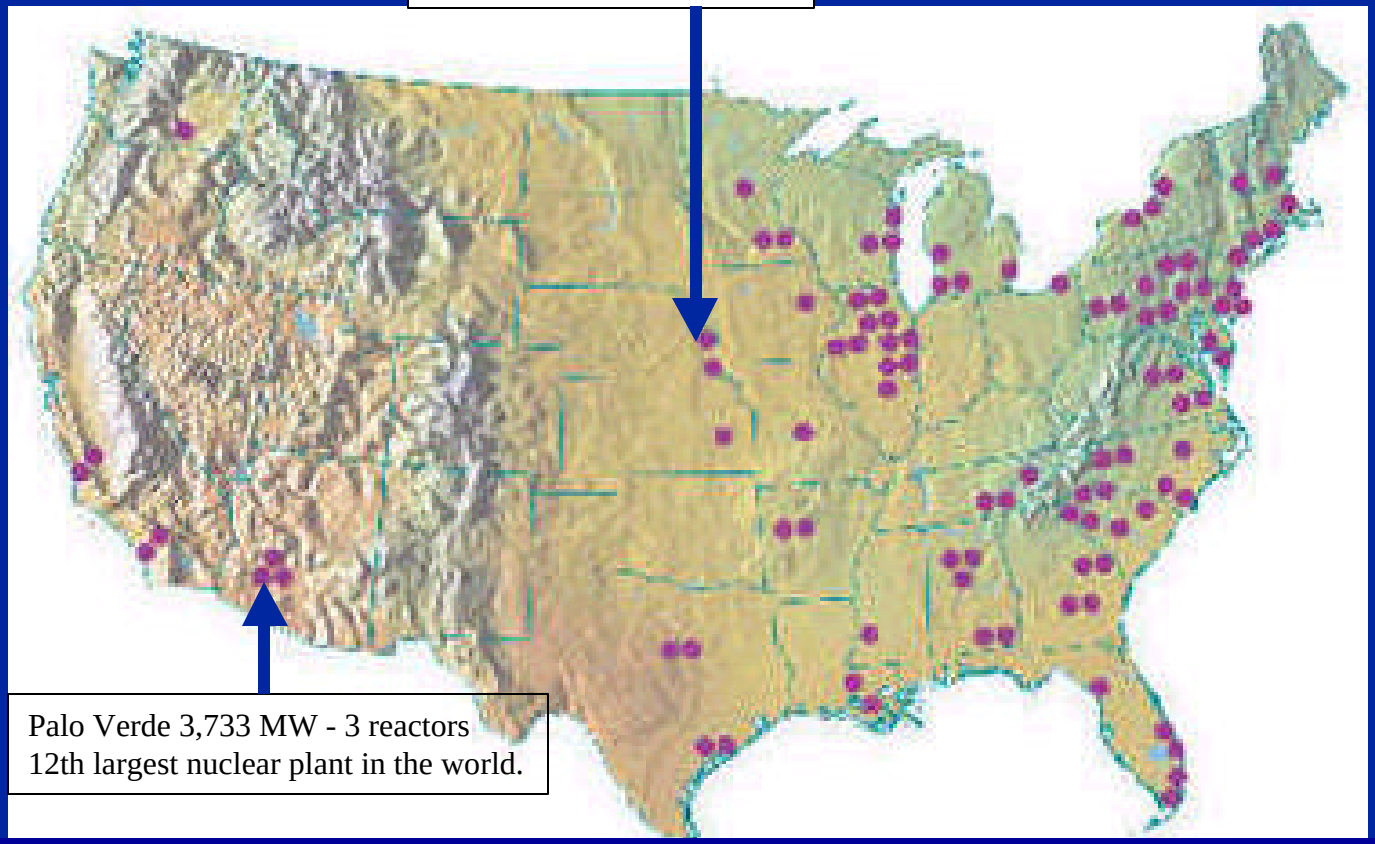


Cycles of World Oil Production is plotted on the basis of two estimates of the amount of oil that will ultimately be produced.


2001 Energy
Growth in Demand
Conservation
LifeStyle Change
Substitution
Deprivation?
Oil Supplies
1900
2000
2050

Nuclear Power

No new reactors ordered since 1978. Many have been decommissioned.



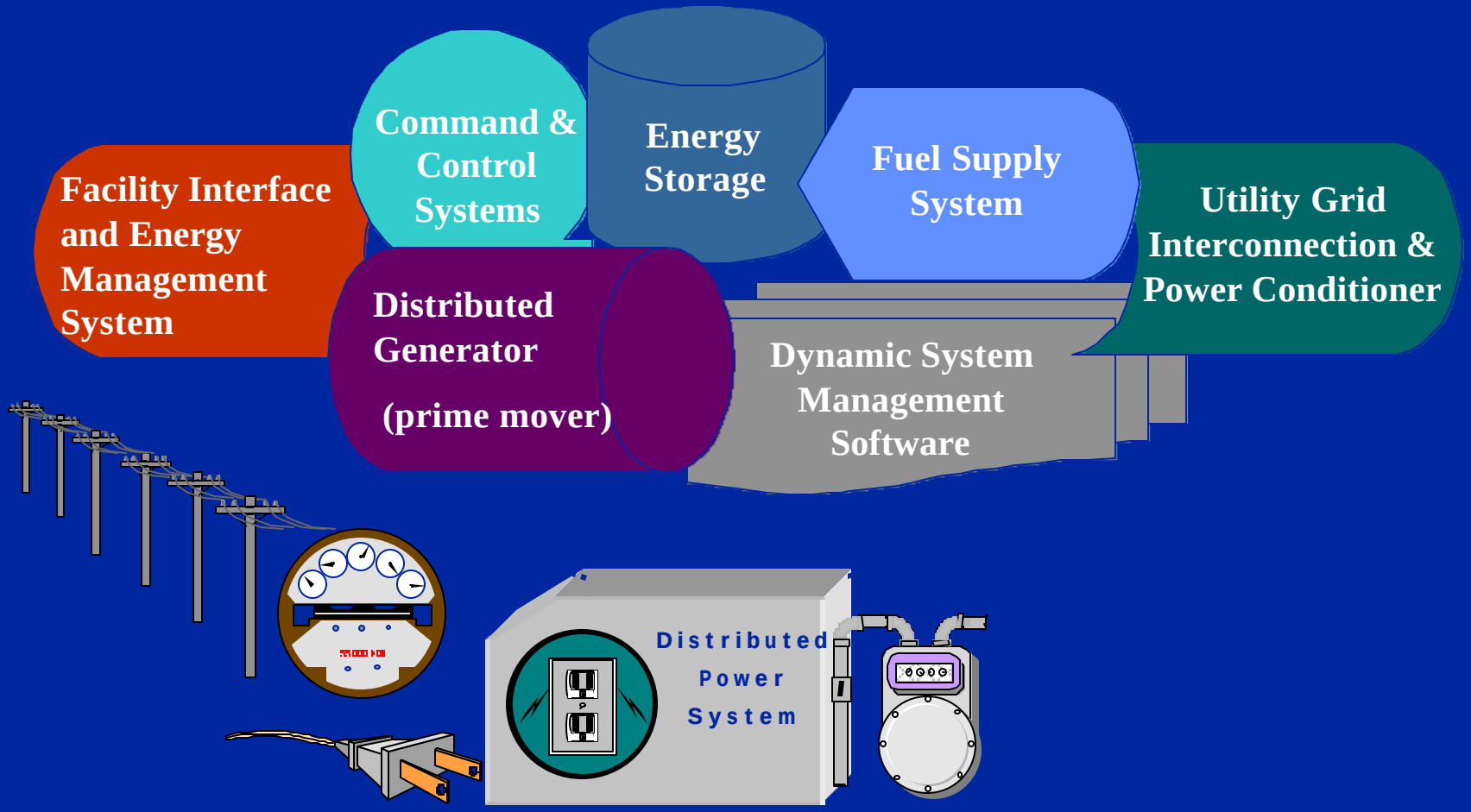
Operational performance has improved dramatically in the past 2 decades
Industry capacity factor is about 85%. But repairs are very expensive.

If there will be a Nuclear Renaissance in the United States…….

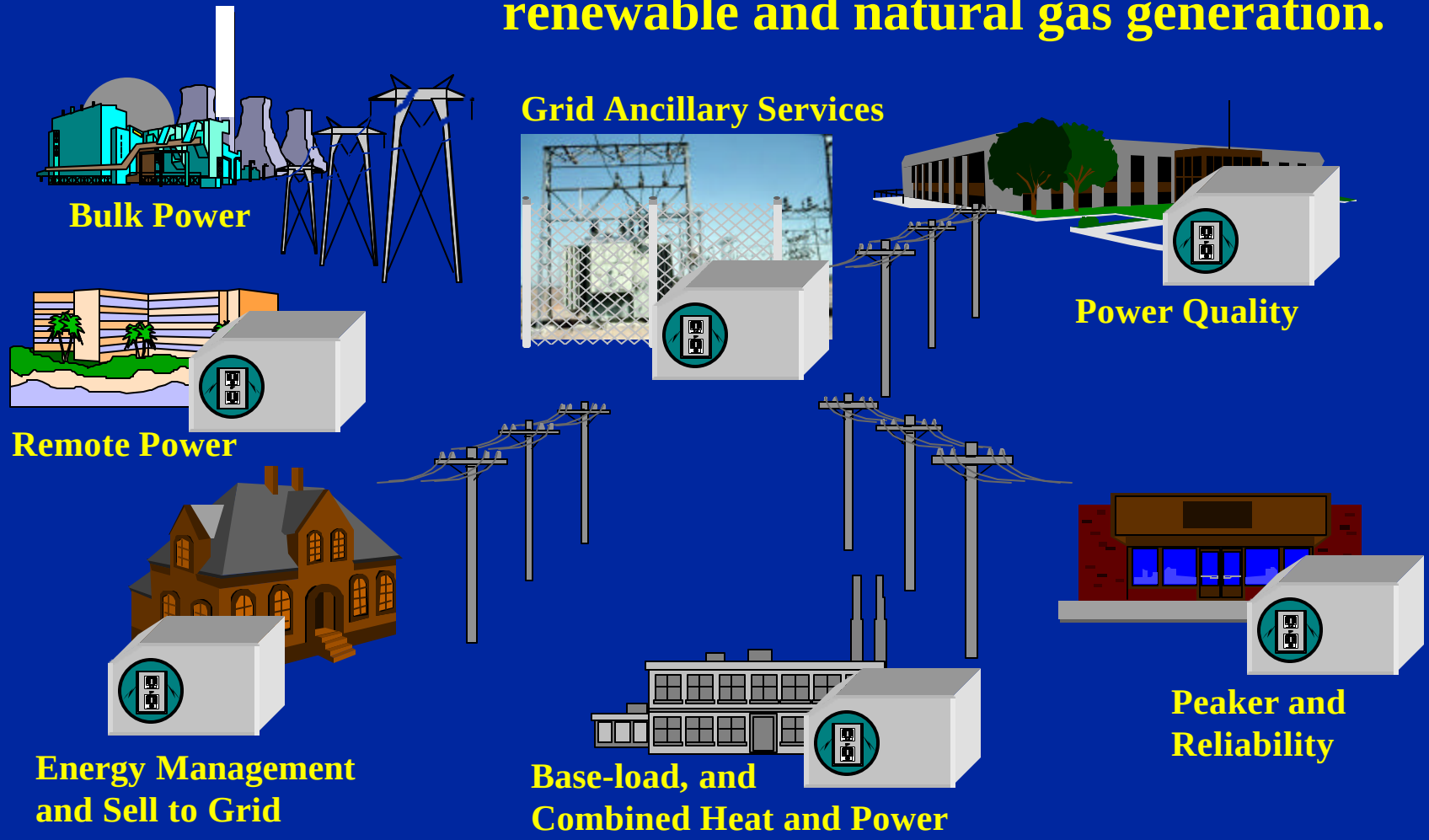
It will likely not be the expensive and trouble-plagued Light Water Reactors and Pressurized Water Reactors

… it will most likely be the Pebble Bed Modular Reactor under development in South Africa.

Distributed Energy Resources



Distributed power is emerging as a new way of producing electric power and holds much promise for renewable and natural gas generation.



Microturbines:
The Promise
The Reality
The Frustration

Fuel Cells

Elegant, Efficient, Clean……
But…..
Expensive and Illusive

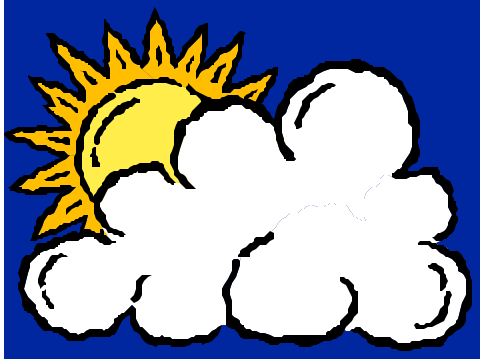
100kW solid oxide fuel cell cogeneration system
Courtesy of Siemens Westinghouse Power Corporation

Solar Shingles

This has all of the appearance of a very successful distributed resource. At the present time, however, this is very expensive.

Renewable Energy

Given the market trends, what's the future for renewables?



Can renewables compete on cost alone?

Do they have to compete on cost alone?

It may depend on consumer and policy preferences...

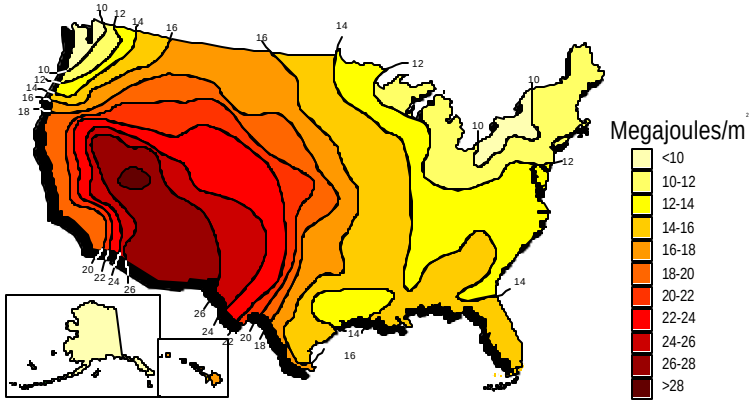
Renewable Energy Pathways

- Wind Energy
- Solar Photovoltaics
- Solar Thermal Electric
- Solar Buildings
- Biomass Electric
- Biomass Transportation Fuels
- Geothermal Energy
- Hydropower
- Solar Advanced Photoconversion

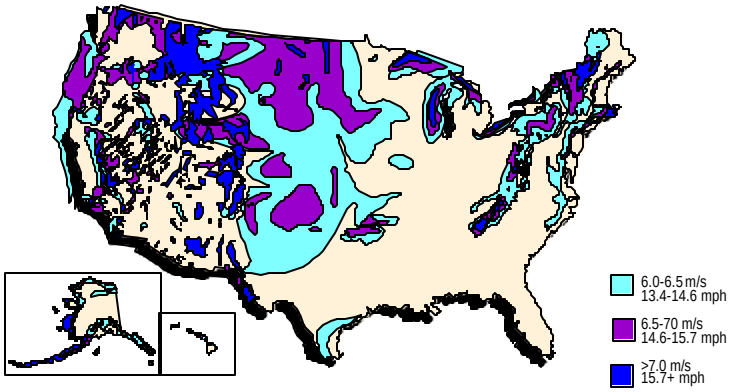
Source: Technology Opportunities to Reduce U.S. Greenhouse Gas Emissions, Oct 1997

Renewable Energy Resources

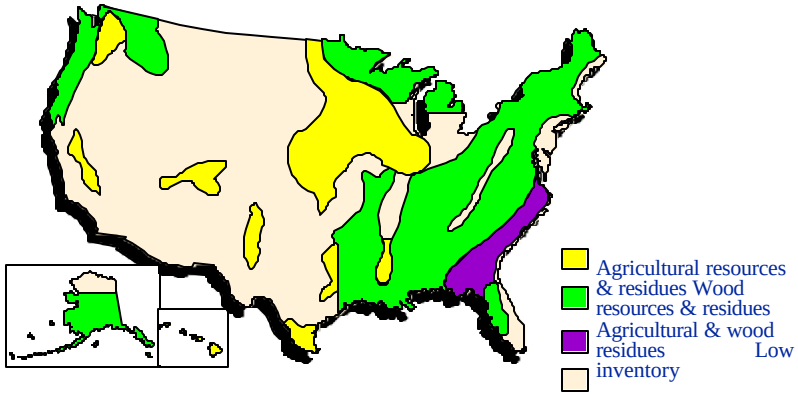
Solar



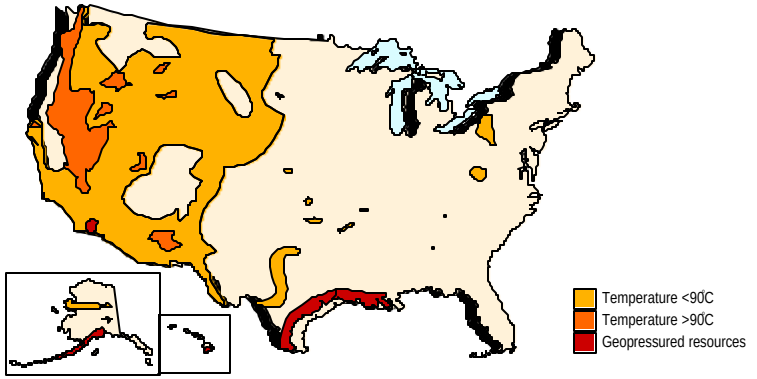
Wind



Biomass



Geothermal



Hydrogen

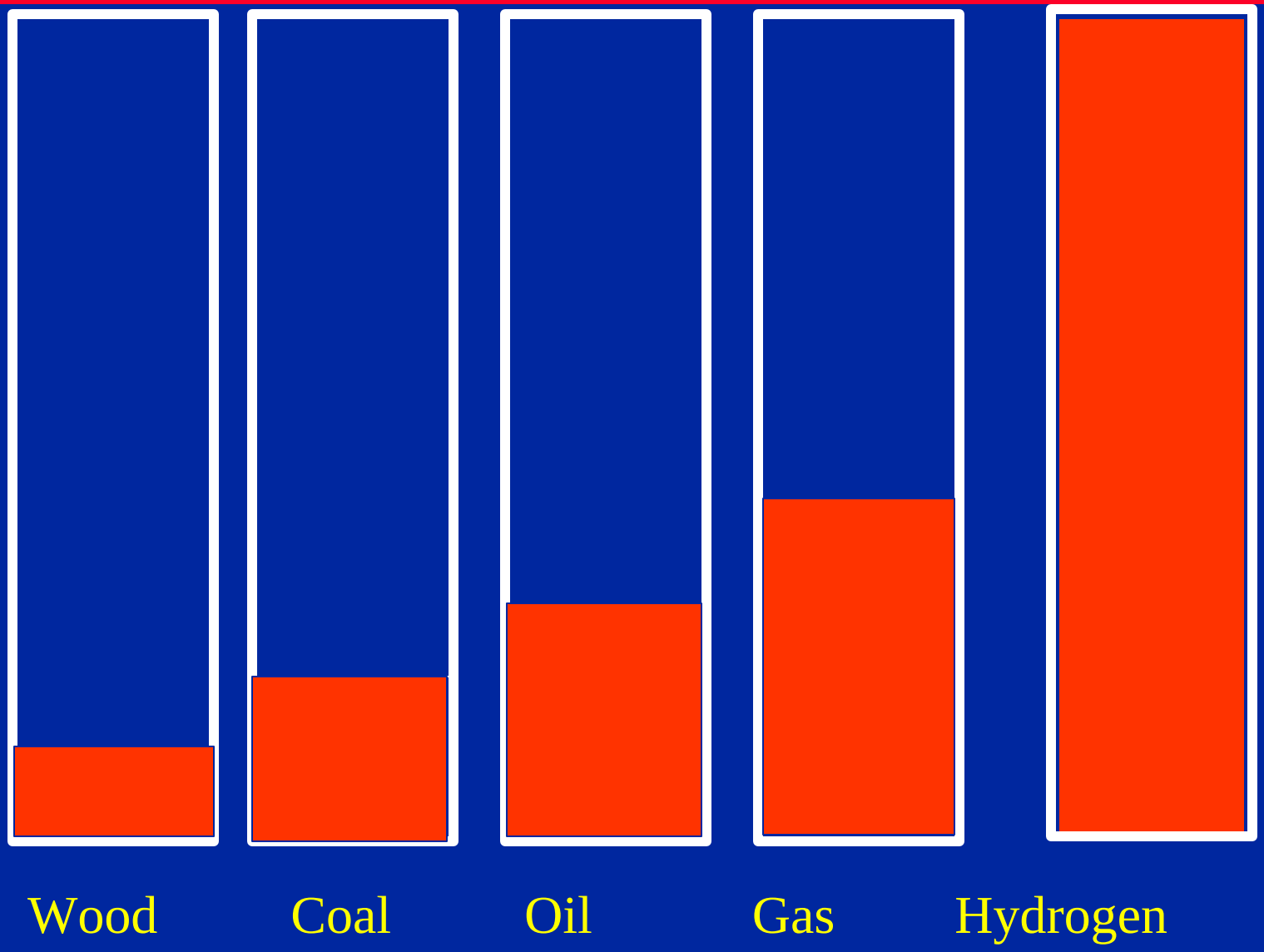
Wood…..
Oil…….
Coal……..
Gas……...

They are all composed of complex chemical chains of Carbon and Hydrogen molecules.

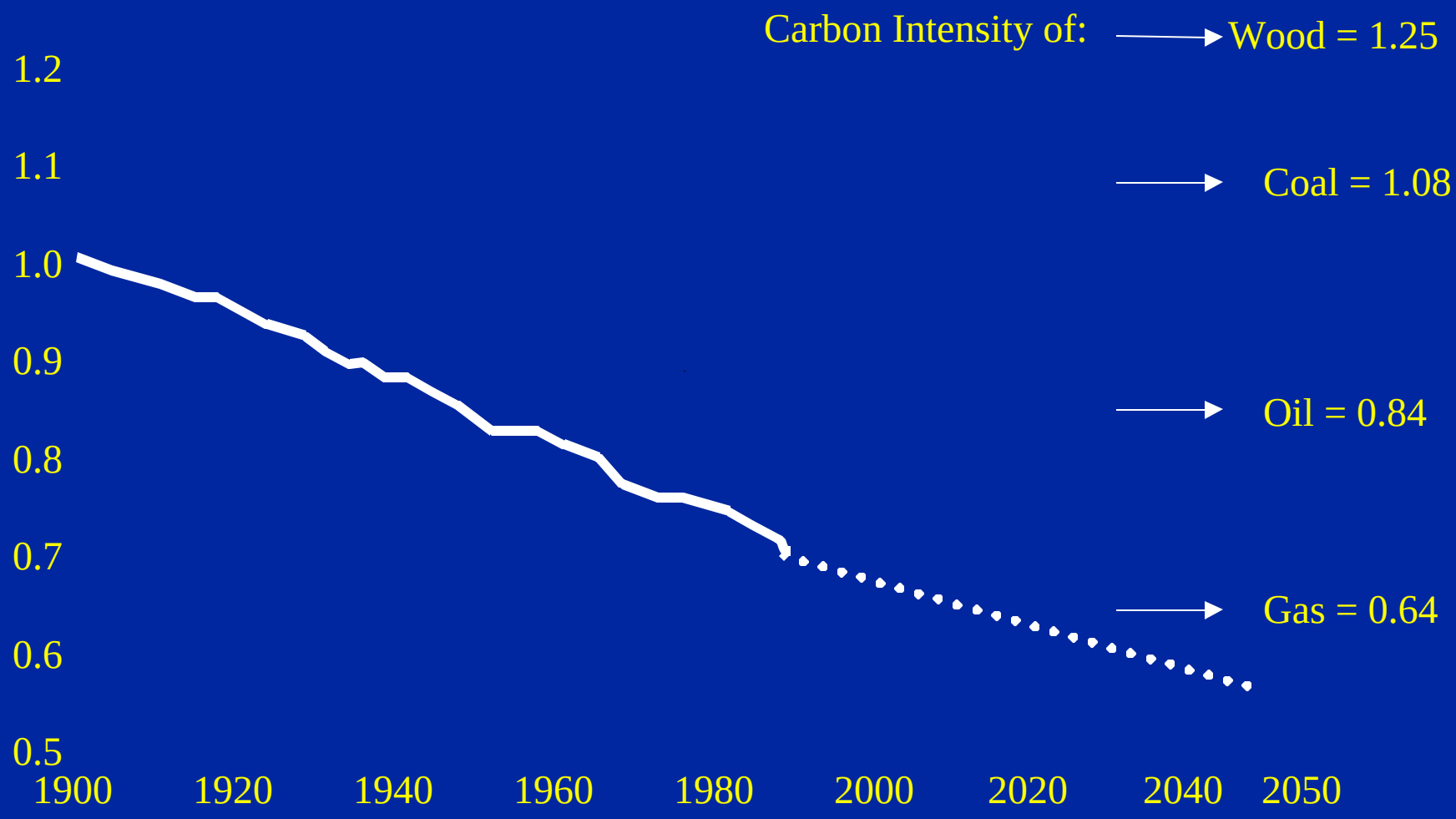
It's the Hydrogen that we're after---that's what burns.
It's the Carbon that gives us the problems.

Let's reach the goal of
……..Safely burning the hydrogen, without the carbon.

Illustrative Hydrogen Content of Fuels



Carbon Intensity of World Primary Energy

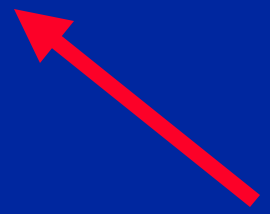


Source: National Academy of Engineering, 1997

Electric Utility Industry Restructuring

- Why Did Half the States Decide to Restructure?
- Why Did Half the States Say “No”?
- What’s Happening Now?

Generation	Transmission	Distribution
Competitive	Natural Monopoly	Natural Monopoly
?????	Regulated	Regulated



Should Utility-Owned Generation be Deregulated?

- Will a competitive marketplace result in consumer benefit?
  - Lower Rates?
  - Technological Innovation?
- Will the result be effective competition?
- Or unregulated monopoly?

Restructuring Policy has been determined at State Legislatures and Public Utilities Commissions, not in Congress, yet.

Outline for Presentation on the Status of Restructuring

- States that have operating “competitive” markets (California, Pennsylvania)
- States that have passed legislation and are in the process of implementation
- States that have passed legislation, and are in the “timetable” phase of beginning implementation
- States that are considering legislation
- States that have studied and either rejected or tabled legislation

Restructuring Influences

- Despite high rates, Alaska and Hawaii have limited opportunity for competition.
- Otherwise, high rates states, such as New England, were the most likely candidates for restructuring.
- California, with high imports of electricity and high rates, was a candidate for restructuring.
- High rates in Sun Belt made those states good candidates.
- Most states with low rates saw no reason to change. Exceptions: Montana, Oklahoma.

Stages of Electric Restructuring

- "Study" 1995-2000
- Legislation 1996-2000
- Monitoring, hand-wringing about lack of competition. 2000-2001
- "Restructurer's remorse" 2001
- Modification / delay / repeal 2001

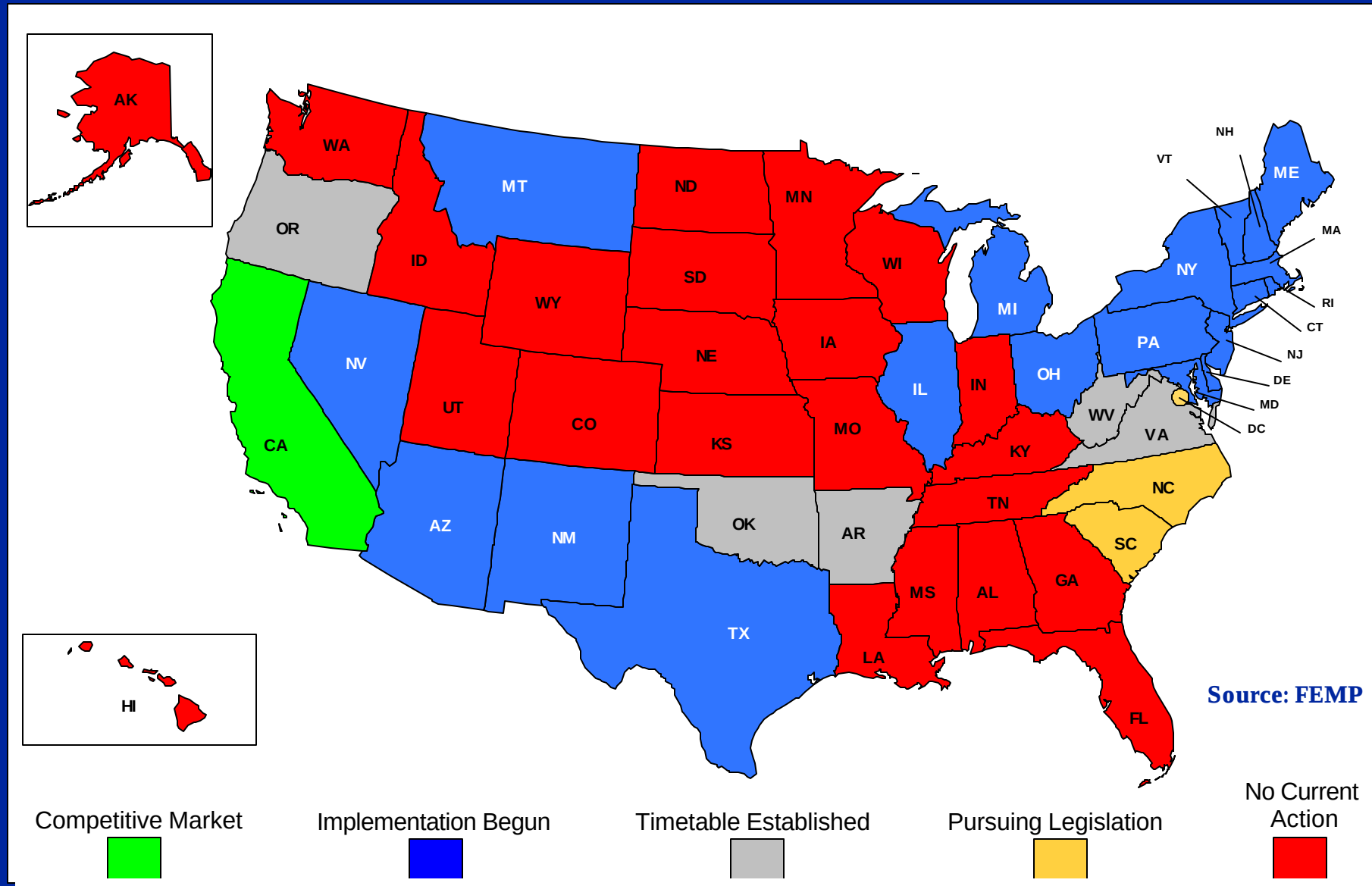
What States are restructuring?

Why are they?

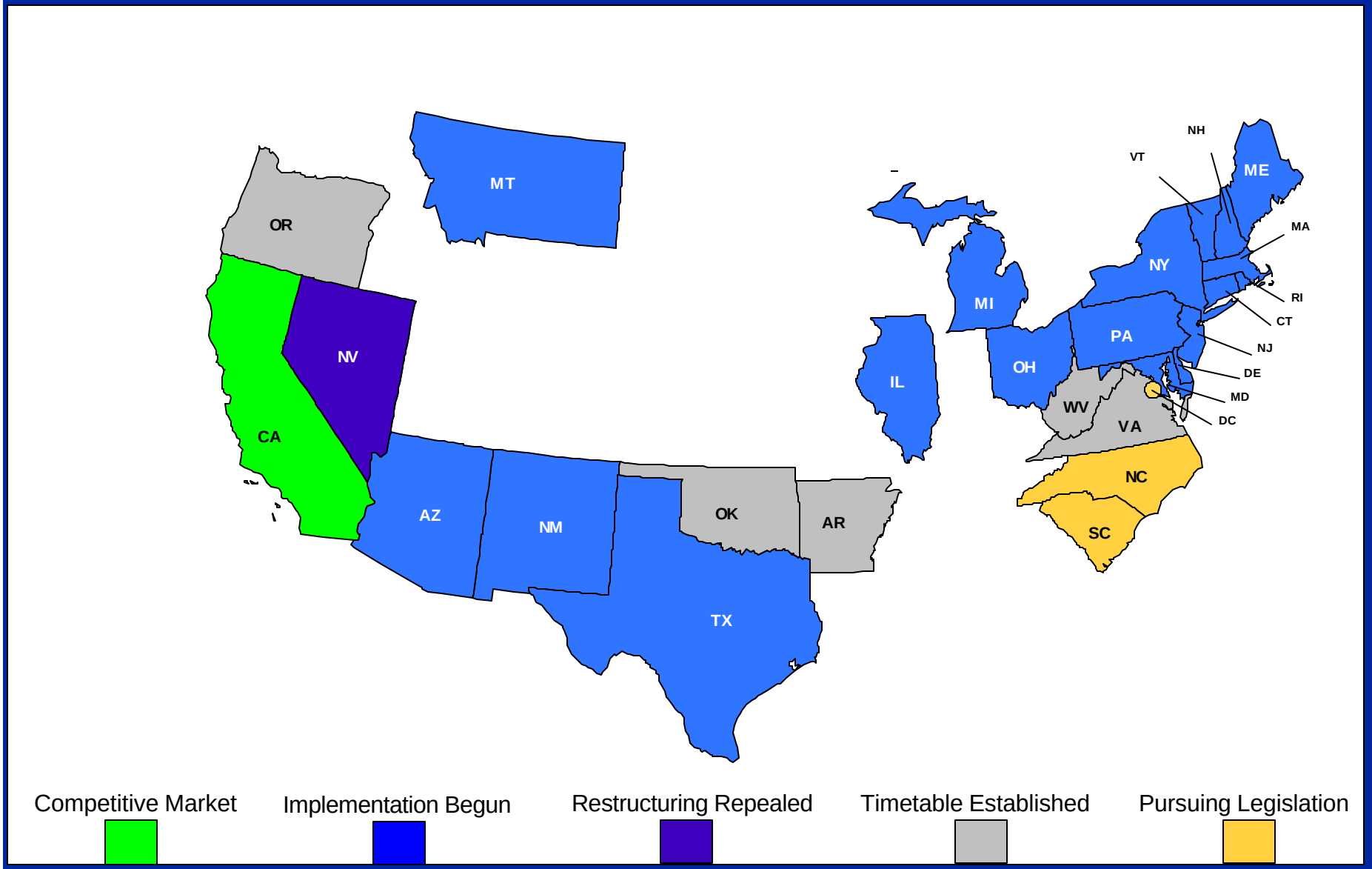
What States are not restructuring?

Why not?

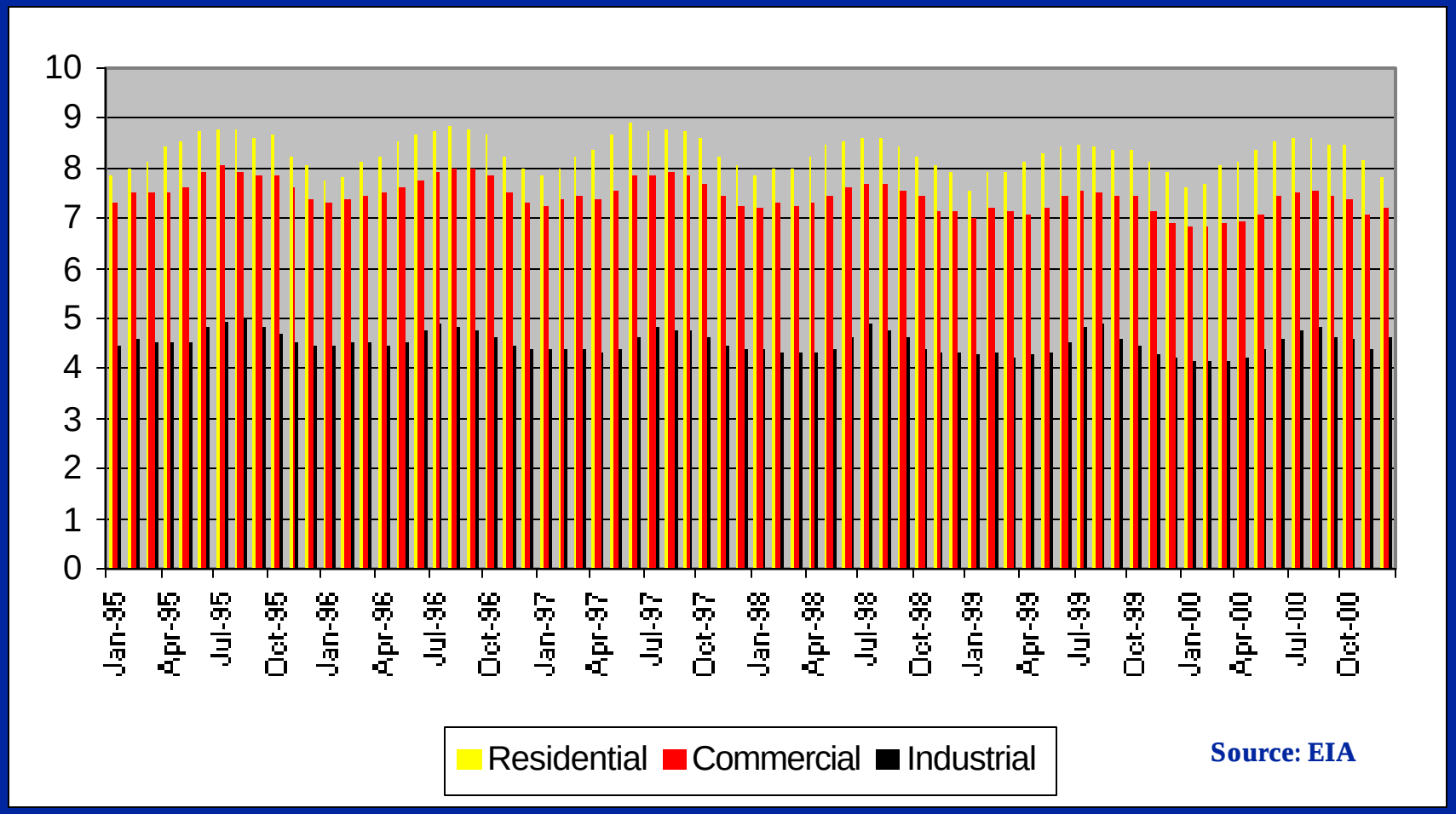
Status of Restructuring-National



Active Restructuring States

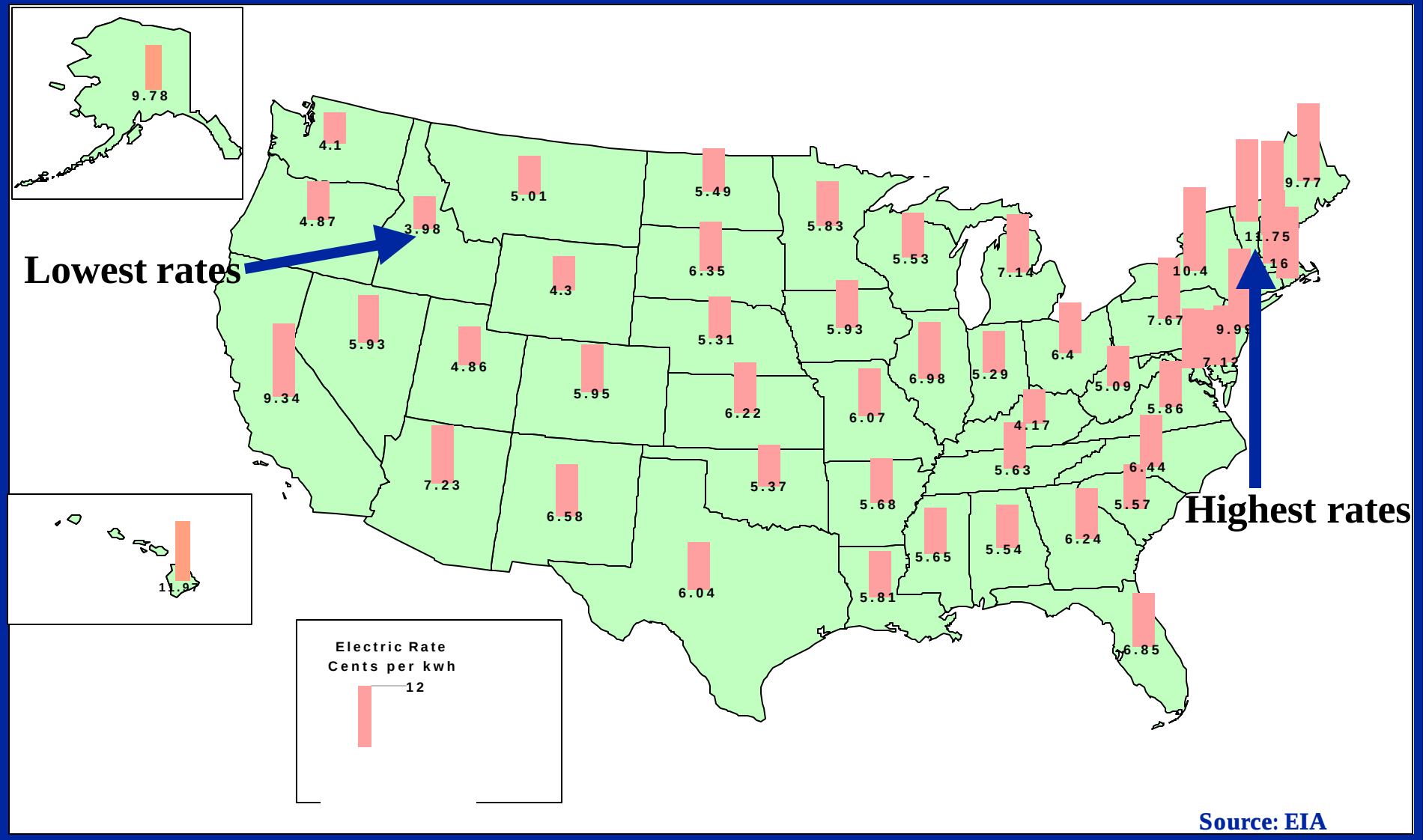


In aggregate, average electricity prices appear to be stable, but…..



Electric Rates Varies Widely by State

Electric Rates, 1999



Source: EIA

Status of the only state with "Competitive Market" denomination

-Significant price increases in San Diego starting summer 2000

- "Direct Access" abolished in February 2001

-"Rolling blackouts" since winter 2001, forecasted through summer 2001

-PG&E filed for Chapter 11 in April 2001

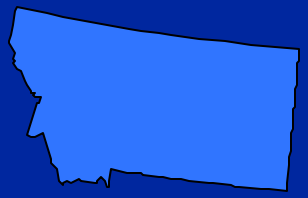
-State pursuing acquisition of transmission facilities

-State requesting FERC price caps

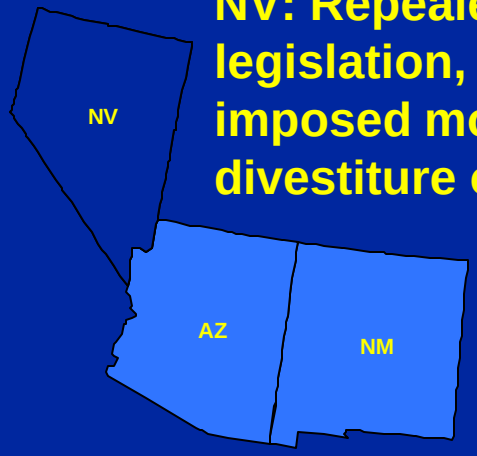
-Allegations of price gouging

-Significant rate increases announced in May 2001
-etc., etc., etc.

Status of Selected Implementing States



MT: Delayed start of retail implementation until 2004; Montana Power wants out of power business

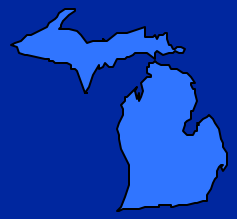


NV: Repealed restructuring legislation, April 18, 2001; imposed moratorium on utility divestiture of generation assets

AZ: Legislation called for full retail competition by January 1, 2001

NM: Delayed start of retail implementation from 2002 to 2007

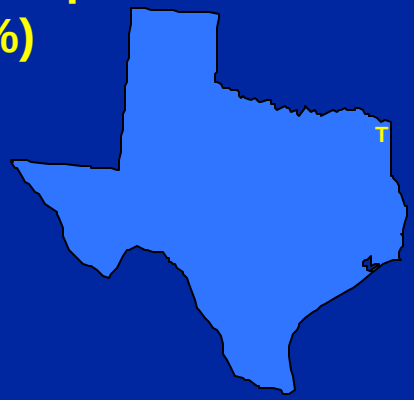
Status of Selected Implementing States



MI: Limited participation in competitive market

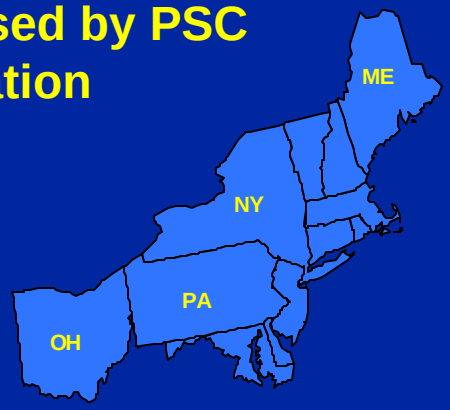
IL: Corp.Comm. reports that few eligible customers have exercised choice

TX: Pilot program began February 15, 2001; participation is limited to date (~15%)



Status of Selected Implementing States

NY: Changes proposed by PSC to increase participation

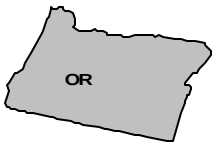


OH: Retail access began January 1 2001

PA: All customers have retail choice; PUC estimates cost savings of up to 10%

Status of "Timetable" States

OR: Act provides for rate plan choices, Not full retail access; legislature considering delay in implementation



WV: Legislation requires delay to complete study of deregulation prior to implementation

VA: Retail choice by January 1, 2004

OK: Conferees have signed out a bill delaying until at least 2003, and formation of a study group.

AR: Implementation delayed from January 1, 2002 to October 1, 2003

States Pursuing Legislation

DC: Existing supplier divested generation assets; customer choice legislation passed in May 2000

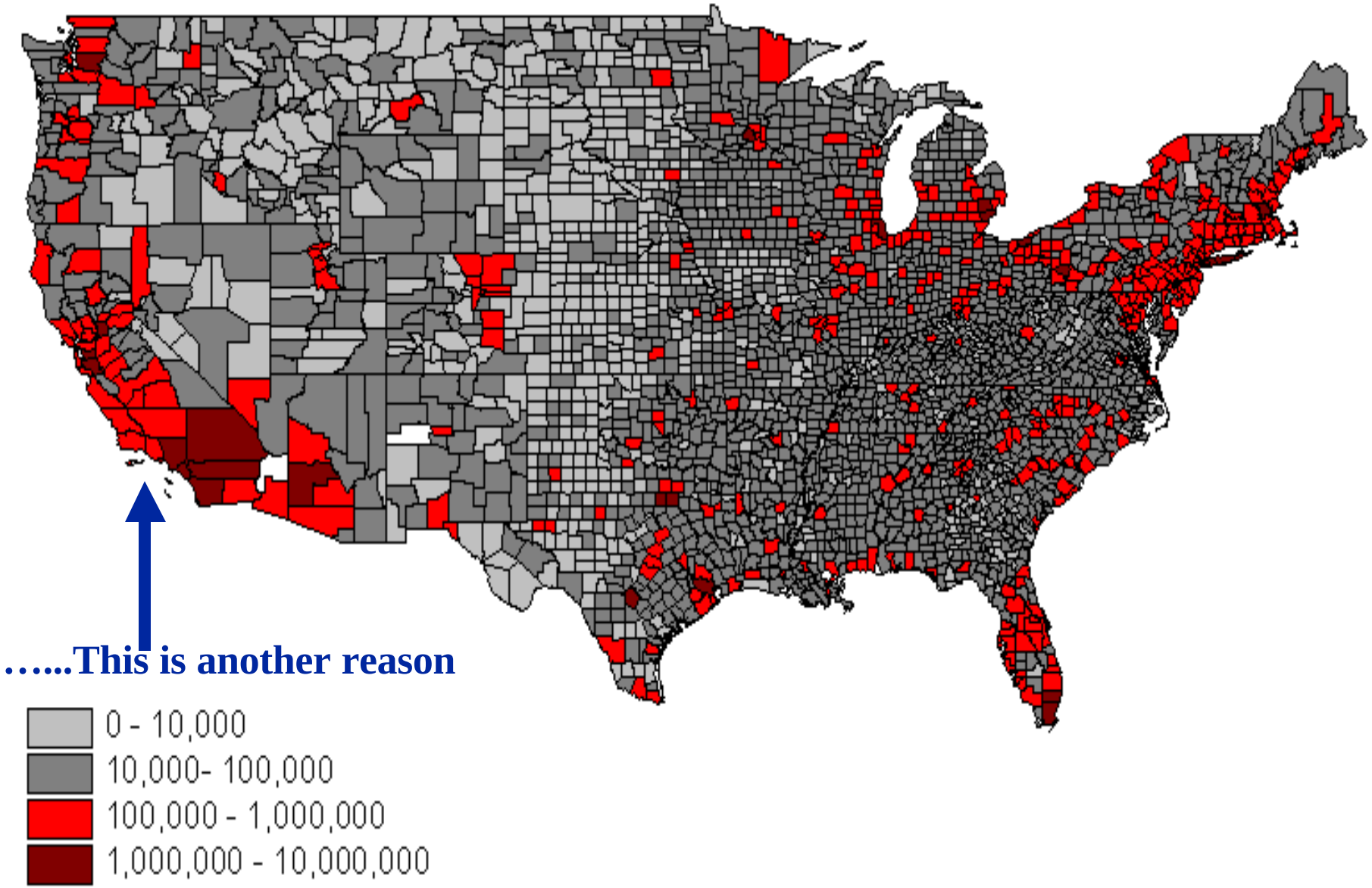
NC: Study recommends full retail access by January 2006

SC: Study estimated high costs for deregulation; no bill passed to date

The States that are Not Restructuring:

Why Aren't They Restructuring?

This is one reason……..



…...This is another reason

The Theory of Restructuring Legislation

The typical political trading that happened when states considered restructuring:

Utilities get deregulation.

Consumers get legislatively mandated rate freezes and reductions for a few years, then “all bets are off.”

Industrial, large commercial customers get choice of suppliers.

Oil and gas industries enter electric markets.

Renewables and low-income get revenue stream for a few years, then “all bets are off.”

Free marketeers get “open markets.”

Some Concluding Thoughts Regarding the Long-Term Energy Picture

Challenges Facing Conventional Approaches

- Electric System
  - Restructuring — From "inevitability" to "stop or reverse"
  - Coal — Starting to expand, environmental concerns
  - Hydro — Not expanding
  - Nuclear — Despite new push, likely will not expand
  - Gas — Rapid expansion, price volatility, overbuild?
  - Transmission — Investment has plummeted
  - Distribution — With distributed resources emerging, a very uncertain future
- Fuels
  - Transportation
    - Oil — National security, price volatility, inefficiencies
  - Renewables — Increasing, but starting from a small base
- Buildings
    - Efficiency — Challenge of financing improvements

Energy transformation has historically been measured in several decades.

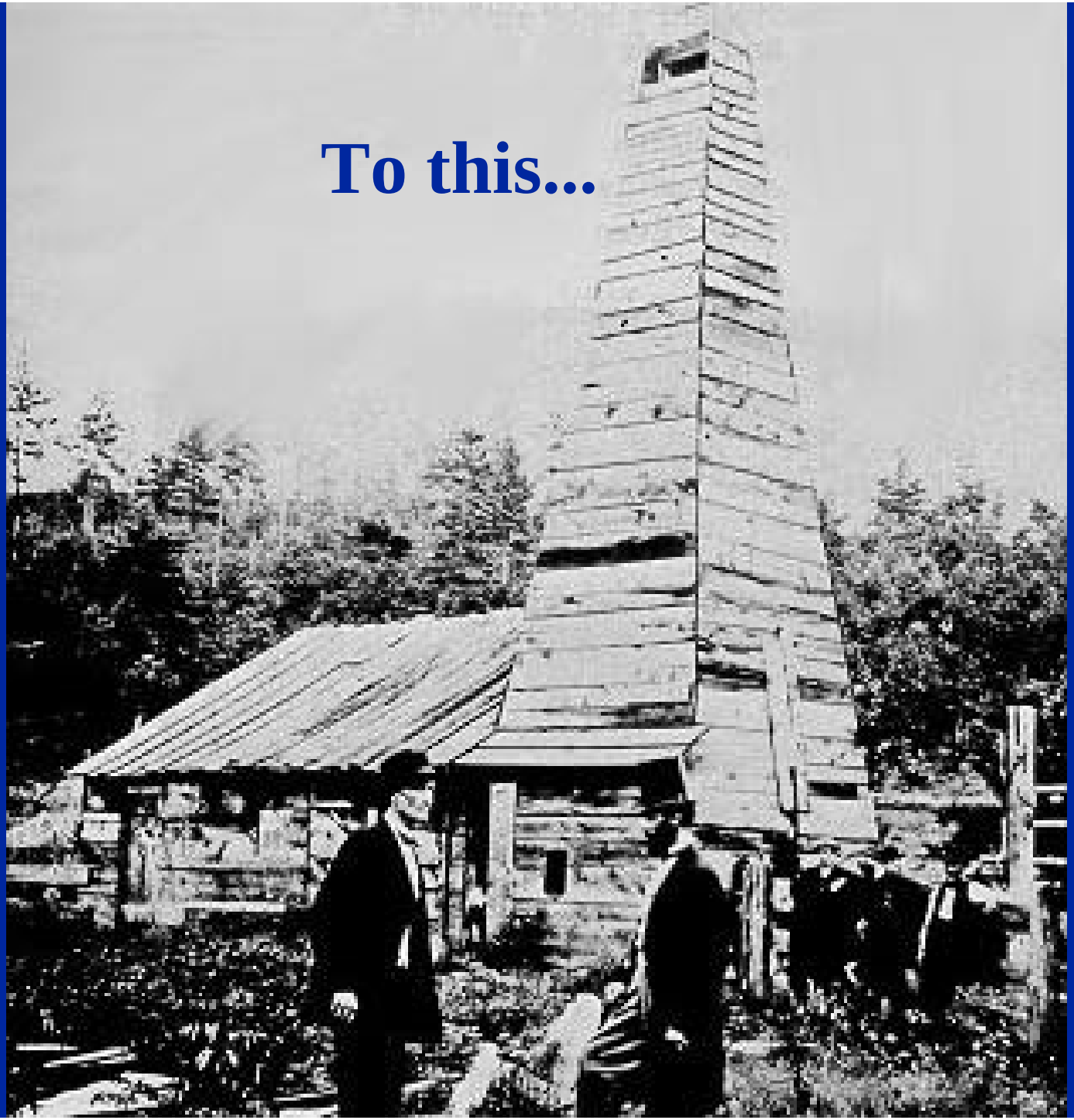
But now, economic progress, high tech skills, national security concerns, and environmental quality ought to encourage us to speed things up.

The public is becoming increasingly aware of the need for energy progress……

Can we take the transformation from this…..

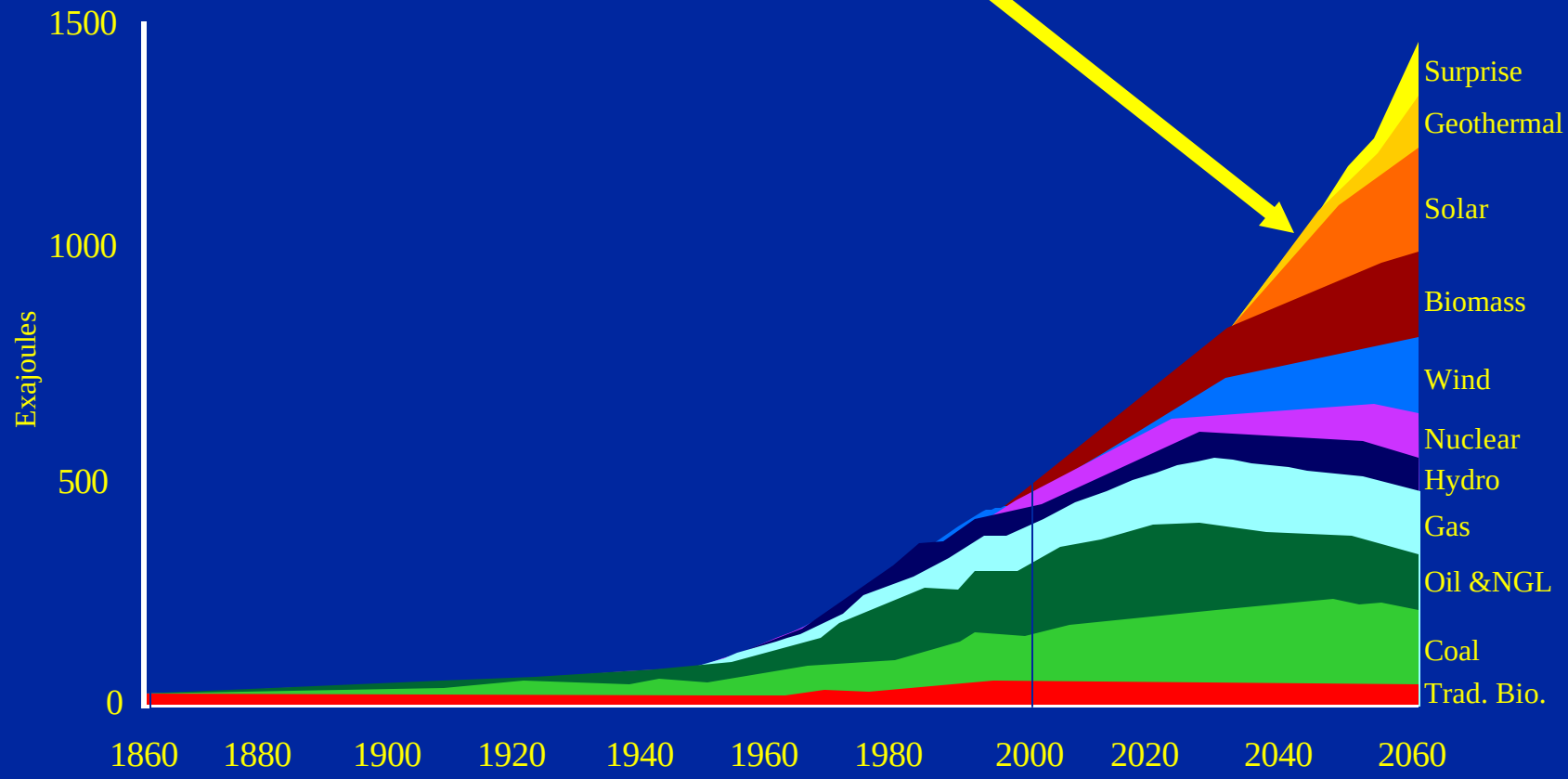

to this….

To this...



to this…..

To This?



Source: *Shell, The Evolution of the World's Energy Systems*, 1995

To power, light, heat, and chill this?

Thanks.

We have time for questions and answers.